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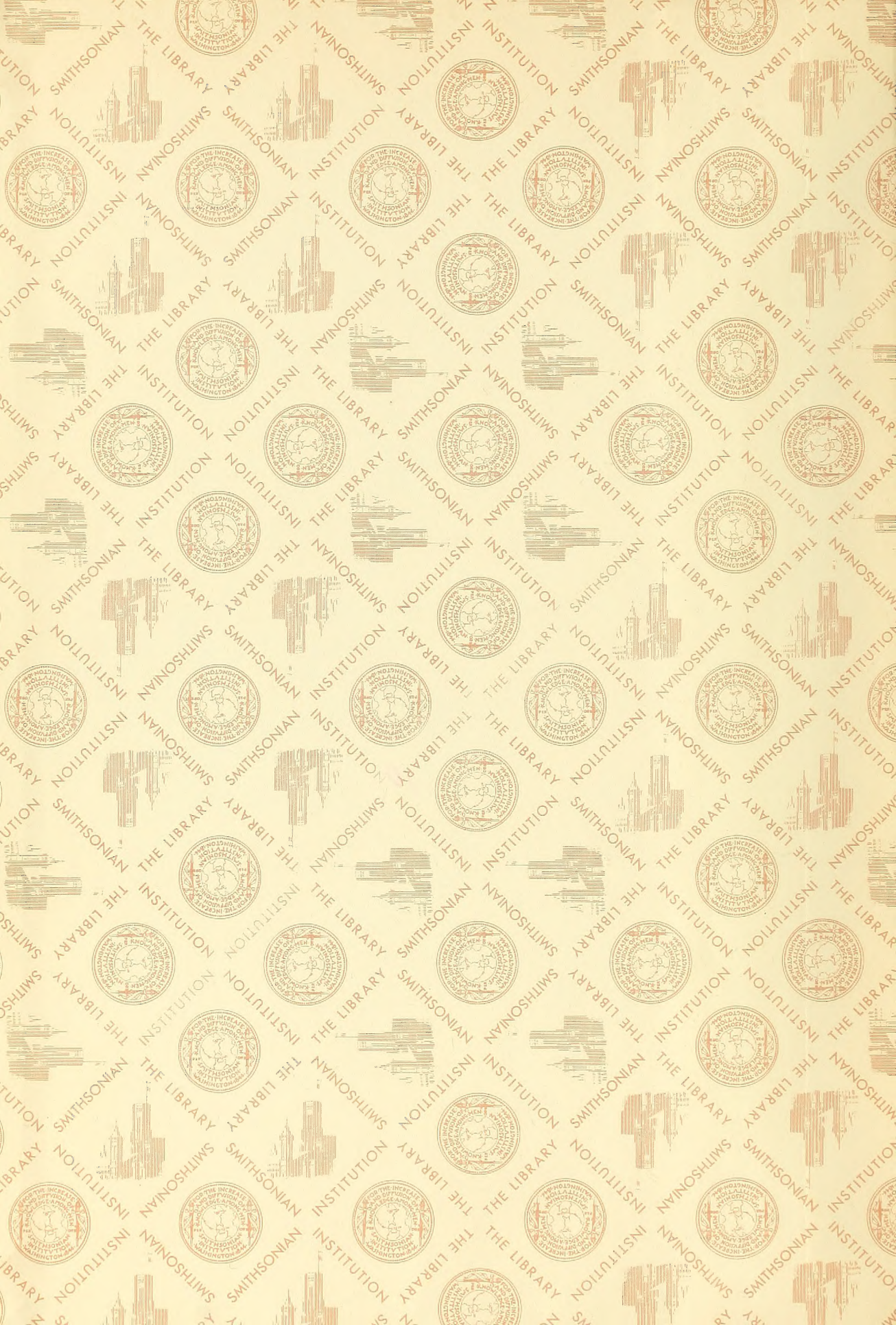
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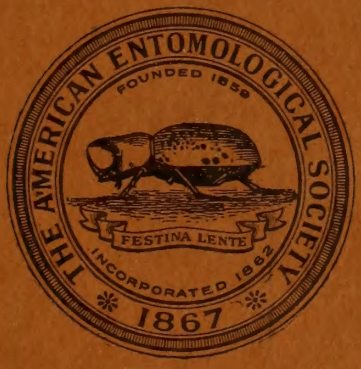
# A TAXONOMIC STUDY OF THE NORTH AMERICAN LICININI

## WITH NOTES ON THE OLD WORLD SPECIES OF THE GENUS DIPLOCHEILA BRULLÉ

(COLEOPTERA)

BY

GEORGE E. BALL

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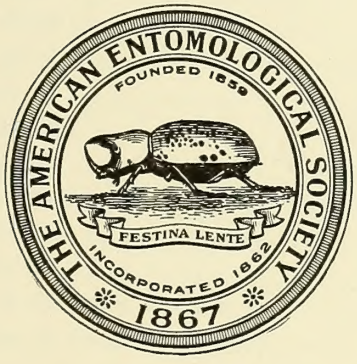


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AT THE ACADEMY OF NATURAL SCIENCES
PHILADELPHIA
1959

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(*Issued January 30, 1959*)

PRINTED IN THE UNITED STATES OF AMERICA

WICKERSHAM PRINTING COMPANY

LANCASTER, PENNSYLVANIA

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# TABLE OF CONTENTS

I. Introduction ..... 1

II. Taxonomic Treatment ..... 3

III. Tribe Licinini ..... 5

Key to the genera of North American Licinini ..... 10

Key to the genera of Oriental Licinini ..... 11

Genus *Diplocheila* ..... 12

Subgenus *Diplocheila* ..... 22

Key to species ..... 23

Subgenus *Neorembus* ..... 40

Subgenus *Isorembus* ..... 48

Key to species ..... 48

Phylogeny of the genus *Diplocheila* ..... 86

Zoogeography of the genus *Diplocheila* ..... 95

Genus *Dicaelus* ..... 98

Subgenus *Paradicaelus* ..... 103

Key to species ..... 104

Subgenus *Dicaelus* ..... 145

Key to species ..... 148

Subgenus *Liodicaelus* ..... 168

Key to species ..... 169

Phylogeny of the genus *Dicaelus* ..... 182

Zoogeography of the genus *Dicaelus* ..... 185

Genus *Badister* ..... 189

Subgenus *Badister* ..... 191

Key to species ..... 192

Subgenus *Trimorphus* ..... 217

Subgenus *Baudia* ..... 219

Key to species ..... 220

Phylogeny of the genus *Badister* ..... 231

Zoogeography of the genus *Badister* ..... 237

IV. Acknowledgments ..... 241

V. References ..... 242

VI. Explanation of Figures ..... 250

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# A TAXONOMIC STUDY OF THE NORTH AMERICAN LICININI WITH NOTES ON THE OLD WORLD SPECIES OF THE GENUS DIPLOCHEILA BRULLÉ (COLEOPTERA)

BY GEORGE E. BALL

*(Department of Entomology, University of Alberta)*

## I. INTRODUCTION

Students of the North American Carabidae, with few exceptions, have been concerned primarily with the description of new species and with the presentation of keys to aid in the determination of species. Little attention has been paid to subjects such as geographical variation, relationships, evolution and historical geography, which are considered here. However, this remark is not intended as a criticism, because before such topics can be considered a foundation of sound descriptive taxonomy must be prepared and adequate material must be available for study. The fine work of Le Conte and Horn during the nineteenth century provided the basis for more detailed studies of the North American Licinini, and the collections housed in the larger public and private museums in the care of able, cooperative curators provided the needed material.

The purpose of this study was to elucidate interspecific relationships of the North American Licinini, and to this end the status of the described species was evaluated in terms of variation in external morphol-

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ogy, structure of the male genitalia and female retractile plates, and geographical distribution. Taxonomic results of these studies were some new synonymy, and the description of two new subgenera, three new species, and five new subspecies.

Studies in *Diplocheila* and *Badister,* begun with the species of the North American fauna, led to a consideration of the Old World species of these two genera. The result was, in the case of *Diplocheila,* preparation of a synopsis of the Old World species of this genus. Data obtained from examination of certain of the Palaearctic species of *Badister* were helpful in preparing a classification of the North American species of this genus.

Finally, representatives of several Oriental and Australian genera of Licinini, and descriptions and illustrations of African genera were studied in an effort to arrive at an understanding of the position within the tribe of the licinine genera which occur in North America, resulting in the preparation of a generic classification.

The following material was examined: *Diplocheila,* New World, nine hundred three specimens; Old World, one hundred forty one specimens, representing fourteen species; *Dicaelus,* two thousand four hundred eighty specimens representing fifteen species; *Badister,* New World, six hundred sixty-six specimens, representing fifteen species, Old World, twenty-one specimens, representing seven species; one specimen each of *Lacordairia, Siagonyx, Hormacrus, Platylytron, Dilonchus,* and *Dicrochile;* a series of about twenty specimens of *Omestes torta* Andrewes.

This paper is a summary of data obtained from a study of a large percentage of the preserved specimens of Licinini available for examination on the North American continent. Some of the older taxonomic problems have been solved, and new problems have been discovered which cannot be resolved with the available material. Therefore, our knowledge of the taxonomy of the species treated in this study is incomplete, and so still more specimens and, perhaps, more perceptive students, are required. Thus this revision is hardly a definitive study but is more in the nature of a report of progress in the understanding of the licinine Carabidae. It is dedicated to those who have preceded me in the study of this fascinating group of beetles, and have thus made this contribution possible.

## II. Taxonomic Treatment

*Criteria for Species and Subspecies.*—Two similar forms were regarded as distinct species if their geographical ranges overlapped and if they exhibited no intergradation or tendency to intergrade in at least one morphological character (color excluded). However, two forms which were largely allopatric but with morphologically intermediate specimens in geographically intermediate areas were regarded as being conspecific. Two allopatric forms not connected by morphologically intermediate specimens were judged to be specifically distinct or conspecific depending upon the nature of the characters separating them. If these characters were of the same magnitude as those distinguishing good species, then the two forms were regarded as being specifically distinct. Allopatric forms of a single species were regarded as being subspecifically distinct if at least 75% of one form could be distinguished from 75% of the other. This value is low compared to that recommended by Mayr *et al.* (1953: 142-146), but comes closer to the traditional definition of the subspecies. In the case of clinal variation, only samples representing geographically extreme populations were named, and then only if they could be distinguished by two or more characters.

*Measurements and Ratios.*—All measurements reported in this study were made with a ruled ocular in a stereoscopic microscope under a magnification of 10X or 40X. The margin of error at a magnification of 10X is 0.1 mm.±; at 40X, 0.025 mm.±.

### Measurements

*Length of head*—linear distance from base of mandible to posterior margin of eye, usually measured on the left side.

*Width of head*—maximum value, including eyes.

*Length of clypeus*—distance from basal to apical margin medially.

*Width of clypeus*—maximum distance along transverse plane of clypeus.

*Maximum length of labrum*—distance from base to apex of longest lobe.

*Minimum length of labrum*—distance from base to deepest part of median emargination.

*Width of labrum*—distance across base of labrum.

*Length of mandible*—distance from apex to lateral dorsal articulation.

*Width of mandible*—maximum distance across terebra, including tooth, if present.

*Length of antennal scape*—distance from basal constriction (just in between ball joint and main portion of scape) to apex along anterior margin.

*Length of terminal palpal segment (maxillary or labial)*—distance from base to apex along outer margin.

*Width of terminal palpal segment (maxillary or labial)*—distance from margin to margin at apex.

*Length of pronotum*—distance along median longitudinal plane from base to apex.

*Maximum width of pronotum*—greatest transverse distance across pronotum anterior to base.

*Width of pronotum at apex*—transverse distance across apical angles.

*Width of the pronotum at base*—transverse distance between the posterior angles of the pronotum.

*Length of elytra*—distance from basal margin (transverse line at base of elytral striae) to apex.

*Width of elytra*—maximum transverse distance across both elytra together, or the sum of the maximum widths of each elytron.

*Maximum width*—maximum width of both elytra.

Abbreviations Used to Designate Measurements

L—length; W—width; max.—maximum; min.—minimum; ant. seg. 1—antennal scape; PN—pronotum; wp—widest point; El—elytra.

Total length, as used here, consists of the sum of the length of the head, length of the pronotum, and length of the elytra, these measurements being taken as described above. The mandibles are not considered because they may be crossed so that it is impossible to get an accurate measurement of one or the other. Because the head may be drawn into the thorax for a varying distance, the area behind the eyes was eliminated from consideration. These measurements may be made rapidly and can be duplicated readily by other workers because they are made between fixed points.

Some of the numerical data obtained were subjected to rudimentary

statistical analysis, using the methods outlined by Cazier and Bacon (1949), and Mayr *et al.* (1953, Chapter 7).

*Synonymy.*—The only references given are those which are important from a nomenclatural point of view, thus excluding lists of local faunas. The citation of references in the synonymy follows the system used in Leng (1920), for example "*Dicaelus laevipennis* Leconte, 1848: 321". The numbers before the colon give the date of publication of the name; the numbers following the colon, the page on which the name is to be found.

## III. Tribe LICININI

Licines Bonelli, 1813: 442.
Thoraciques Latreille and Dejean, (in part), 1822: 79.
Patellimanes Dejean, (in part), 1826: 281.
Licinidae Brullé and Audouin, 1834; Hope, 1838: 82; Erichson, 1860: 341 & 342; Jeannel, 1942: 986.
Licinini Erichson, 1837: 22; Horn, 1881: 139; Ganglbauer, 1892: 31 & 376; Bedel, 1895: 16; Everts, 1898: 33; Sloane, 1898; 1920: 120 & 166; 1923: 245; Reitter, 1900: 144; 1908: 74 & 75; Csiki, 1907: 292; Barthe, 1909: 5; Blatchley, 1910: 64 & 112; C. Schauf, 1916: 6 & 56; Porta, 1923: 43 & 210.
Chlaeniidea Westwood, (in part), 1838: 5.
Dicoelites Castelnau, 1840: 131.
Licinides Laferté, 1851: 274; Lacordaire, 1854: 231.
Licini Le Conte, 1853: 387.
Licinites Jacq. du Val, 1857: 13.
Chlaenidae Mars, 1880: 191.
Chlaeniina Seidlitz, (in part), 1891: 11.
Licinina Î Akobson, 1905: 200.
Licinitae Jeannel, (Licinidae in part), 1942: 991; 1949: 771.
Badisteritae Jeannel, (Licinidae in part), 1942: 999; 1949: 773.

Ball (1954) has reviewed the history of the classification of the Tribe Licinini.

*Diagnosis of the Tribe.*—The distinguishing characteristics of the Tribe Licinini are: anterior tibiae anisochaetous; middle coxal cavities of the conjunct type (mesepimeron does not attain coxae), metepimeron lobed, anterior coxal cavities biperforate, mandibles without a setigerous puncture in the scrobe, submentum deeply emarginate, with or without a small tooth medially; elytra not truncate apically, elytral epipleurae not interrupted posteriorly by an internal plica.

In most licinine genera the labrum and clypeus are both emarginate. However, in *Diplocheila distinguenda, Genycerus,* and *Dilonchus* the

anterior margin of the clypeus is almost straight, but the labrum is emarginate. In the Australian genus *Siagonyx* the labrum is short and transverse, and the anterior margin is bisinuate, not deeply emarginate. Thus the possession of both an emarginate labrum and clypeus by a species of the Limbata Conchifera (*sensu* Jeannel, 1942) probably places that species in the Licinini, but the absence of these characters does not necessarily exclude it.

Within the North American carabid fauna, licinines are distinguished from the rest of the Harpalinae (*sensu* Horn) by the possession of two supraorbital setae over each eye, and by having both the labrum and clypeus emarginate.

*Classification.*—As indicated by Jeannel (1942) the position of the Licinini with respect to the other Tribes of Carabidae seems to be satisfactory. On the basis of structure of the male genitalia and number of foramina in the anterior coxal cavities, as well as larval characters, he has grouped the Licinidae with the Callistidae and Panagaeidae to form the superfamily Callistomorphi (or what I prefer to call a supertribe), but within this group it does not seem possible to relate the Licinidae to the other two components.

The first attempt at classifying the genera of this tribe was made by Jeannel. On the basis of overall size and shape of the genitalia he divided the Licinidae into two subfamilies: Licinitae and Badisteritae. Apparently all of the licinine genera are included in the typical subfamily, except the genus *Badister* (*s. lat.*) which seems to be the sole member of the second subfamily. I do not agree with this arrangement, mainly because of the great similarity of *Badister* to *Licinus*, and because of the dissimilarity between these two genera and *Diplocheila* and *Dicaelus*. Therefore, I propose a different alignment of the genera which is based on structure of the mandibles. However, the classification is tentative because I have seen only a few representatives of genera other than *Badister, Diplocheila,* and *Dicaelus.*

Several types of mandibles occur within the Licinini, and they may be described, roughly, as follows: first type, more or less trigonal in shape, of moderate length, with more or less narrow apices, terebra at least one-half the total length; second type, mandibles short, broad, the dorsal surface of one or both notched in several of the component genera, apices obtuse, thick, frequently notched, terebra very short; third

type, mandibles flattened, elongate, apices curved inward, sharply pointed, and with a prominent, sharply pointed tooth on inner margin near apex, terebra short; fourth type, mandibles somewhat flattened, apices sharp, curved, inner margin with small teeth about ⅓ of the distance from apex to base, terebra relatively short. On the basis of these mandibular types I classify the licinine genera.

Group 1. Genera with mandibles of the first type: *Dicaelus* and *Diplocheila.*

Group 2. Genera with mandibles of the second type: *Licinus, Eurygnathus, Badister, Omestes, Colpostoma, Tricholicinus, Martyr,* and *Physolesthus.*

Group 3. Genera with mandibles of the third type: *Lacordairia, Lestignathus, Siagonyx, Platylytron, Hormacrus, Dilonchus, Genycerus, Microferonia, Atrotus, Zargus.*

Group 4. Genera with mandibles of the fourth type: *Dicrochile.*

Unclassified: *Eutogeneius* and *Mecynognathus.*

As I have not seen representatives of either of the last two genera, and as the descriptions of their mandibles are inadequate, I cannot place them in this scheme.

The mandibles of *Dicrochile* may possibly represent the archetypal condition from which the mandibles of the Group 2 type developed. Horn (1881: 140) noted that *Dicrochile goryi,* which has the tips of the mandibles bifid, has the general aspect of an elongate *Badister,* and this similarity of appearance may imply more than it would seem to at first glance.

If, on the basis of other supporting characters, these groups are found to be natural, I suggest that they be treated as sub-tribes.

*Geographical Distribution.*—Although the Licinini are represented in all of the major zoogeographical regions of the world most of the genera are endemic to one region or another (see table 1). Note also that the genera are small. The combination of relatively small genera and high endemism suggests that the group is an old one, for a large amount of endemism seems to indicate relatively long residence in a given area, and small genera suggest that much extinction has taken place. However, the possibility that the genera are small because they have evolved recently must be borne in mind. Which way the evidence

is viewed probably depends on the distinctness of the genera: if they are all clearly differentiated then they are probably old; if poorly defined and very close together morphologically they are probably young.

Until more is known concerning intergeneric relationships, little can be derived from a study of distribution. However, certain interpretations seem reasonable to me from the data available at present. First, the general paucity of Licinini in the New World seems to indicate that the center of evolution and dispersal of this tribe was the Old

TABLE 1

DISTRIBUTION OF THE GENERA OF THE TRIBE LICININI.

| | | Region | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Neotropic | | Nea. | Pal. | Ethiopian | | | |
| Genera | No. Species | S.A. | Ant. | | | Afr. | Mad. | Or. | Aust. |
| GROUP 1 | | | | | | | | | |
| *Diplocheila* ..... | 22 | | x | x | x | x | x | x | |
| *Dicaelus* ..... | 15 | | | x | | | | | |
| GROUP 2 | | | | | | | | | |
| *Eurygnathus* .... | 1 | | | | | x | | | |
| *Licinus* ..... | 20 | | | | x | | | | |
| *Derostichus* ..... | 1 | | | | x | | | | |
| *Tricholicinus* .... | 1 | | | | x | | | | |
| *Colpostoma* ..... | 5 | | | | x | | | | |
| *Martyr* ..... | 2 | | | | x | | | | |
| *Badister* ..... | 34 | | x | x | x | x | x | x | |
| *Omestes* ..... | 1 | | | | | | | x | |
| *Physolesthus* .... | 6 | | | | | | | | x |
| GROUP 3 | | | | | | | | | |
| *Lestignathus* .... | 4 | | | | | | | | x |
| *Lacordairia* ..... | 6 | | | | | | | | x |
| *Siagonyx* ..... | 3 | | | | | | | | x |
| *Hormacrus* ..... | 2 | | | | | | | | x |
| *Platylytron* ..... | 1 | | | | | | | | x |
| *Microferonia* .... | 6 | | | | | | | | x |
| *Genycerus* ..... | 1 | | | | | | | x | |
| *Dilonchus* ..... | 1 | | | | | | | x | |
| *Atrotus* ..... | 12 | | | | | x | | | |
| *Zargus* ..... | 5 | | | | | x | | | |
| GROUP 4 | | | | | | | | | |
| *Dicrochile* ..... | 28 | | | | | | | | x |
| UNCLASSIFIED | | | | | | | | | |
| *Mecynognathus* .. | 1 | | | | | | | | x |
| *Eutogeneius* ..... | 1 | x | | | | | | | |

World, and that only a few forms succeeded in getting into the New (provided that a present-day center of diversity is an index of center of origin and dispersal). Second, members of Group 3 (as defined above) occur in Australia, the Oriental Region, and in the Ethiopian Region but not anywhere else. It may be surmised that the center of evolution and dispersal of this group of genera was south of the latitude of the Palaearctic Region, and that this group may have arisen in pre-Cretaceous time, before Indo-Australia was fragmented, thus arriving in Australia via solid land. This same stock, dispersing westward, may have reached the Ethiopian Region and there, subsequently, differentiated into two genera. Third, the center of origin of Group 2 may have been the Palaearctic Region as most of the living genera occur there today. Early dispersals from this area may have produced the ancestral stock of *Badister* in the Oriental Region, as well as of the genera *Omestes* and the Australian *Physolesthus*, and the ancestral stock of *Eurygnathus* on the island of Madeira. On the other hand, the same pattern would have developed if the ancestral stock of this group arose farther south, possibly in the Oriental Region, and, subsequently, largely withdrew. The ancestral stock of Group 1 probably arose somewhere in the Oriental Region or in eastern Asia. An early dispersal to the New World produced the ancestral stock of *Dicaelus*, and later differentiation and dispersal of the Old World stock produced the living species of the genus *Diplocheila*. *Dicrochile* and *Mecynognathus* may be remnants of once more widely distributed groups. *Eutogeneius*, if it is a licinine, may represent the remains of an early New World incursion, possibly in Cretaceous or pre-Cretaceous time, either via North America and the Panama land bridge, or via Antarctica.

## *Key to the Genera of North American Licinini (Adults)*

1. Dorsal surface of at least one mandible with a broad, deep, transverse notch behind which is a prominent boss ..... 2
   Neither mandible as above ..... 5
2. Dorsal surface of head, pronotum, and elytra smooth, not punctate, elytral intervals 3, 5, and 7 not raised, antennal segments 1-2 glabrous, 3 pubescent, terminal segments of palpi more or less cylindrical, apex narrowly truncate ..... *Badister* (*s. lat.*) 3
   Dorsal surface of head, pronotum, and elytra coarsely punctate, elytral intervals 3, 5, and 7 elevated slightly above 1, 2, 4, and 6, antennal segments 1-3 glabrous, terminal segments of palpi triangular, broadening from base to apex, apex broadly truncate .... *Licinus silphoides* Fabr.[1]
3. Right mandible with a deep notch in dorsal surface, left normal ..... 4
   Left mandible with a deep notch in the dorsal surface, right mandible normal ..... subgenus *Baudia* Ragusa
4. Claw-bearing segment of tarsus with each ventro-lateral margin bearing a row of setae, lines of microsculpture of pronotum forming isodiametric meshes, surface not iridescent .. subgenus *Badister* (*s. str.*) Clairville
   Claw-bearing segment of tarsus ventrally without two rows of setae, lines of microsculpture of pronotum forming transverse meshes, surface strongly iridescent ..... subgenus *Trimorphus* Stephens
5. Episterna of the metathorax strongly transverse, approximately rectangular in shape, outer margin little, if at all longer than anterior margin, about as wide posteriorly as anteriorly, claw bearing segment of tarsus with a row of setae on each ventrolateral margin, striae 8 and 9 a moderate distance apart, stria 7 no deeper in apical 1/5 than in basal 4/5
   *Dicaelus* (*s. lat.*) 6
   Episterna of the metathorax elongate, outer margin at least 1.25 times longer than anterior margin, distinctly narrower posteriorly than anteriorly, claw-bearing segment of tarsus ventrally without two rows of setae, striae 8 and 9 very close together, stria 7 deeper in apical 1/5 than in basal 4/5 .... *Diplocheila* Brullé, subgenus *Isorembus* Jeannel
6. Penultimate segment of the labial palpus bisetose ..... 7
   Penultimate segment of the labial palpus with at least 4 setae
   subgenus *Dicaelus* (*s. str.*) Bonelli
7. Elytral striae moderately deep, the intervals convex
   subgenus *Paradicaelus, nov.*
   Elytral striae absent, or indicated only by rows of shallow punctures, intervals flat ..... subgenus *Liodicaelus* Casey

Keys to the known larvae of Licinini may be found in van Emdem, (1942: 144) and Jeannel (1942: 990).

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[1] An introduced Palaearctic species, not recently recorded in North America.

## *Key to the Genera of Oriental Licinini*

1. Either right or left mandible with a deep notch in dorsal surface ..... 2
   Neither mandible notched ..... 4
2. Elytra with apices not spinose, antennae with segments 1-2 glabrous, right or left mandible notched, penultimate segment of labial palpus bisetose *Badister* (*s. lat.*) 3
   Elytra with apices spinose, antennae with segments 1-3 glabrous, right mandible deeply notched, penultimate segment of labial palpus quadrisetose ..... *Omestes* Andrewes
3. Right mandible notched, left normal .. subgenus *Badister* (*s. str.*) Clairville
   Left mandible notched, right normal ..... subgenus *Baudia* Ragusa
4. Mandibles more or less trigonal, striae 8 and 9 very close together, stria 7 deeper in apical 1/5 than in basal 4/5, separated from stria 8 by a narrow carina in apical 1/5 ..... *Diplocheila* (*s. lat.*) 5
   Mandibles flattened, apices sharp, incurved, elytral striae 8 and 9 a moderate distance apart, stria 7 not deeper in apical 1/5 than in basal 4/5, not separated from stria 8 by a narrow carina in apical 1/5 ..... 7
5. Front and clypeus flat, not concave, labrum symmetrically emarginate, mandibles either slender, elongate and edentate, or if toothed, then the tooth of the right mandible is not molariform; ventral groove of mandibles with long dense hair ..... 6
   Front and clypeus concave, labrum asymmetrically emarginate, mandibles not unusually slender and elongate, left edentate, right with a broad molariform tooth, ventral grooves with short hair subgenus *Isorembus* Jeannel
6. Mandibles slender and elongate, edentate, labrum with six setae, lobes of labrum slender, elongate, acute apically .... subgenus *Neorembus, nov.*
   Mandibles toothed, labrum with four or six setae, lobes of labrum broader, apices broadly rounded or subtruncate subgenus *Diplocheila* (*s. str.*) Brullé
7. Mandibles narrowed at middle, clypeus emarginate, elytra with scutellar striae vestigial ..... *Genycerus* Andrewes
   Mandibles not narrowed at middle, clypeus not emarginate anteriorly, elytra with well developed scutellar striae ..... *Dilonchus* Andrewes

## Genus DIPLOCHEILA Brullé

The principal diagnostic features of this genus are indicated in the key to the genera. Additional characters, common to all species of *Diplocheila*, are mentioned in the following description.

*Description.*—All species are black, excepting antennal segments 4-11, palpi, trochanters, and femoral bases, which are piceous or rufopiceous. Microsculpture consists of fine meshes, usually isodiametric or slightly transverse on the dorsal surface, more transverse on the ventral surface and legs. The ventral surface is usually slightly iridescent. Macrosculpture consists of lines which are usually fine, arranged as follows: head, postorbital area dorsally with fine transversely directed lines, interorbital area with longitudinally directed lines laterally, front between impressions crossed transversely in some species by two to four lines; pronotum crossed transversely by fine lines which disappear or become faint laterally, elytra either without macrosculpture or with fine, irregularly arranged lines, genae with lines very fine, or short, or absent, head ventrally with transversely directed lines; thoracic sterna smooth medially, or crossed transversely by fine lines, laterally with transverse line, and irregular, longitudinally directed short lines, surface laterally rugulose, more or less; thoracic episterna same as lateral portions of pro- and metepisterna; abdominal sternites rugulose laterally, with fine, short, longitudinal lines, smoother medially, usually with fine transverse lines.

Clypeus usually about twice as wide as long, laterally with one seta on each side. The maxillary and labial palpi are similar, with elongate terminal segments somewhat wider than the penultimate segments, fusiform, the apices narrowly truncate.

The sides of the pronotum are beaded, the bead separated from the discal area by a narrow groove. The posterior margin is straight medially, curved slightly forward laterally to meet the sides. The disc is slightly convex medially, declivous antero-laterally, flattened postero-laterally; median longitudinal impression moderately deep to shallow, usually not attaining the basal or the apical margin; posterior lateral impression linear, in shallow basins in some species. The outer margin of the metepisternum is appreciably longer than the anterior margin. The anterior tarsi of the males have segments 1-3 dilated, spongiose beneath.

The elytra are elongate, widening slightly to posterior ½ ±, the sides parallel for a short distance, then constricting gradually. The posterior margin is slightly sinuate and the sutural angle is acute. The striae usually become shallower apically, excepting 7 which in the apical 1/5 becomes a deep, obliquely directed groove, usually separated from stria 8 by a narrow carina. The hind wings are fully developed in all species studied.

The sixth abdominal sternite is more broadly rounded in the males than in the females. The dorsal surface of the median lobe of the male genitalia has

four sclerotized strips apically. The internal sac apically has two sclerotized plates, otherwise it is unarmed.

*Distribution.*—The species of *Diplocheila* occur in all of the zoogeographical regions, excepting the Australian. There are none in continental South America.

*Mandibles of the Genus Diplocheila.*—The interspecific variability of mandibular structure within the genus was first noted by Andrewes (1922: 284) who used the number of teeth along the incisory, or inner margin, as a diagnostic character in a key to the Indian species. He noted only the variation in number of teeth on the inner margin of the mandibles. Study of the mouthparts has disclosed several additional important characters which are described here and are used in the classification of the species.

Jeannel (1926: 285-293) discusses the mandibles in general, and trechine mandibles in particular, and presents a system of nomenclature for the various areas of the mandibles. I have adopted his nomenclature in describing the mandibles of the Licinini, and have added the following four parts which he did not mention: on the left mandible—terebral tooth, for the basal, angular projection of the inner margin of the terebra; terebral margin, for the dorsal most inner margin, the anterior continuation of the terebral tooth; the retinacular ridge, for the carina lying ventrad of the terebral margin, which is the anterior continuation of the retinaculum; the premolar ridge, the anterior ventral continuation of the premolar tooth, extending only to the anterior margin of the retinaculum. The nomenclature of the right mandible presents certain difficulties because both premolar and retinaculum are missing, with only the terebral tooth evident. Only two margins or ridges are apparent on the inner edge: the dorsal most, terebral, as on the left mandible, and the ventral one which may represent the retinacular ridge, and I designate it as such here because it seems to originate directly behind the terebral tooth in the same relative position as the retinacular ridge on the left mandible. Additional evidence is afforded by the structure of the right mandible of *Carabus nemoralis* Mulsant. This species has a very well developed retinaculum, and exhibits a ridge which arises from the anterior portion of that structure and is in the same relative position as the ventral ridge on the mandible of *Diplocheila.*

The following general description of the mandibles is based largely on representatives of each of three species, representing what I consider to be the three major types of mandibles seen in the genus. These are *polita* Fab., (figs. 1a-e), *zeelandica* Redt. (figs. 5a-e), and *latifrons* Dejean (figs. 4a-e).

The left mandible of each of these species is basally trigonal and apically more or less subfalcate, that of *latifrons* being proportionately more elongate and more slender than the other two. The ventral lateral margin is arcuate, with the lateral portion of the base occupied almost wholly by the scrobe, which is deeper in *polita,* shallower in *latifrons.* Further, the dorsal margin of the scrobe is more sharply carinate in *polita* than in the other two species. The dorsal surface of the basal portion is flat in *polita,* except for the posterior portion of a broad, shallow depression which originates behind the terebral tooth, and extends to the middle of the retinaculum. In *latifrons* this depression is somewhat better defined and more extensive, and in *zeelandica* it is most extensive, forming a broad, more or less triangular rugulose depressed area. The dorsal lateral surface of the terebra is narrow in *latifrons,* broader in *polita* and *zeelandica.* In *zeelandica* the anterior dorsal surface of the terebra is flattened for a short distance laterad of the terebral margin, but in *polita* this is not the case, so the dorsal and lateral portions of the terebra anterior to the terebral tooth form an almost evenly continuous curve, the result being that the terebral margin is higher in *polita* than in *zeelandica.* The molar area of the base offers some diagnostic features. In *polita* this area is thumb-like with the apex obtusely rounded, its anterior margin forming an angle of about 120° with the main axis of the mandible, the cutting edge is knife-like and is continuous with the premolar margin. In *latifrons* this area is only very slightly produced, forming an angle of less than 120° with the main axis of the mandible, its apex acute. The cutting edge is wider than in *polita,* its margin composed dorsally of the basal margin (= premolar ridge?) which is continuous with the terebral margin, its ventral margin continuous with the retinacular ridge which, therefore, does not terminate on the dorsal surface of the mandibular base as in *polita.* The molar area in *zeelandica* is broadly produced medially, the inner edge raised moderately above the plane of the dorsal basal surface, inner margin anteriorly forming an angle of about 120° with the tere-

bral margin, the inner edge forming a broad molar which is considerably wider than the more anterior cutting edge, narrowing somewhat posteriorly, with a broad but shallow notch immediately behind the molar which is continuous with the ventral groove. The more dorsal portion of the molar appears to be in part composed of the surface lying between a posterior continuation of the retinaculum and terebral margin, with the ventral portion possibly having been contributed by the ventral surface.

A series of teeth lie anterior to the molar area on the cutting edge of the mandible. These are, in the most generalized condition, from rear to front: the premolar, the retinaculum, and the terebral tooth. The premolar may be present or absent in *polita*. If present it is a low triangular projection lying some distance behind the retinaculum, the dorsal cutting margin being formed by its forward prolongation to the base of the retinaculum. The retinaculum is an upward projecting triangular tooth set at an oblique angle to the axis of the inner edge so that its posterior margin is on the dorsal surface. The retinacular ridge extends forward from the anterior margin of the retinaculum beneath the terebral margin, and laterally of the vertical plane of the latter so that it is not visible from above, to about one-half the total distance from the terebral tooth to the apex of the mandible. The terebral tooth lies cephalad of the retinaculum, is similarly an upward projecting triangle, but considerably broader than the retinaculum, representing the posterior portion of the terebral margin, and terminating on the dorsal surface behind, at about the middle of the retinaculum. A plane drawn at right angles to the termination of this tooth presumably would mark the posterior margin of the terebra. The cutting surface of the mandible of *polita* is a sharp edge, underlain in its proximal portion by a ridge formed by the anterior projection of the retinaculum.

The remaining two species differ rather strikingly in the structure of the cutting edge from that described above. In *latifrons* there are no teeth apparent, but in the area where they may be expected there is a slight outcurving of the margin as seen from above, and the terebral margin is apparently continuous with the inner dorsal margin of the base. The retinacular ridge, and the area between it and the terebral margin all lie in the same vertical plane. The cutting surface thus formed is broader than that surface in *polita*. Posteriorly, the retinac-

ular margin lies in the same horizontal plane as the ventral margin of the cutting edge of the basal area. Thus the inner edge of the mandible is of the same thickness throughout, and there are no apparent breaks in it, as are found in *polita*, in proceeding from one tooth and ridge system to the next. The cutting edge of the left mandible of *zeelandica* shows significant differences from either of the former types. In this species no teeth are evident on the cutting edge anterior to the basal area. However, the retinacular margin is produced medially beyond the vertical plane of the terebral margin so that the functional cutting surface is a beveled edge.

The relative proportions of the areas of the ventral surface of the left mandible exhibit some differences between these species. In *polita* the portion which lies basad of the ventral groove is of only slightly greater extent than the remainder, and the median portion of the latter area is obliquely strigose (figs. 1b and d). In *zeelandica* the basal area is considerably larger than the distal area, a difference due possibly to the decrease in extent of the terebra of the mandibles (figs. 5b and d). Finally, the greatest relative difference between the two areas is seen in the left mandible of *latifrons* (figs. 4b and d), again probably due to the decrease in size of the terebra relative to the area of the base. The hairs of the ventral groove are longer and more numerous in *polita* and *latifrons* than in *zeelandica*.

The right mandible of these three species differs conspicuously from the left, both intra- and interspecifically. In *polita* only the terebral tooth is preserved on the cutting edge, and the terebral margin is higher so that the anterior margin of the tooth is much less pronounced. In *zeelandica* there is a broad molariform area about midway between base and apex on the cutting edge, which probably represents the terebral tooth, and the molar area of the base is not prominently developed as in the left mandible of this species. In *latifrons* the anterior portion of the cutting edge of the right mandible is not concave as in the left mandible but is straight. The cutting margin of the basal area is as in the left mandible. In *polita* the retinacular ridge appears to be represented by a short carina which is continuous with the inner dorsal margin of the basal area and takes its origin at the base of the terebral tooth, extending for a short distance underneath, diverging strongly from the terebral margin. Thus the cutting edge of the right mandible

is essentially the same as the cutting edge of the left mandible, being thin, composed only of the terebral margin anteriorly. The cutting edge of the basal area is moderately broad. In *zeelandica* the cutting edge is very broad, and the terebral tooth is produced into a prominent molariform process, just as wide as the more anterior cutting edge. Posteriorly, however, the cutting edge is considerably narrower, recalling in shape that same area in *latifrons*. Presumably the dorsal margin of the cutting edge is the terebral margin, while the ventral margin of the cutting edge is the retinacular ridge. The edge thus formed slopes outward toward the lateral margin ventrally. In *latifrons* the right mandible corresponds in structure to the left except as noted above. In ventral aspect the relative proportions of the proximal and distal areas are interspecifically of about the same magnitude as for the left mandible. Intraspecifically, however, the distal area of the right mandible is relatively greater than that same area of the left mandible. In *polita* the distal area is heavily strigose, whereas this area is smooth in *zeelandica* and *latifrons*.

The mandibles of the remaining described species of *Diplocheila* resemble more or less either those of *polita* or *zeelandica*, and on the basis of this resemblance and others noted below have been classified with one or the other of these species.

The outstanding features of the three types of mandibles described above are as follows: a. *polita* type—moderately long, broad, blade-like structure, the cutting surfaces composed only of the terebral margin; left mandible with terebral margin concave in a horizontal plane, thus causing the terebral tooth to appear very prominent, terebral tooth compressed, retinaculum present, retinacular ridge prominent, not attaining the apex of the mandible, and not contributing to the formation of the cutting edge, premolar absent or weakly developed, premolar ridge very short, basal area a thumb-like process medially, basal cutting surface a thin edge; ventrally the distal portion is deeply obliquely strigose; right mandible similar to left, terebral margin straight, terebral tooth, therefore, less prominent, and distal area from ventral aspect broader than that of left mandible; retinaculum absent, ridge very short, and strongly divergent from the terebral margin, not forming the cutting edge; premolar tooth and ridge not apparent; cutting edge of base as in left mandible; b. *latifrons* type—mandibles elongate and approxi-

mately similar to one another, edentate; left mandible with the cutting edge moderately broad, of even width throughout; cutting edge concave in a horizontal plane, molar area not thumb-shaped, produced posteriorly rather than medially, as in *polita;* right mandible similar to the left but with cutting edge straight rather than concave; c. *zeelandica* type—mandibles relatively broad, left mandible edentate, right mandible with a single molariform, prominent tooth; incisory edge of the left mandible composed of a more prominent retinacular ridge and a receding terebral margin, molar area with anterior margin very broad and elevated in relation to the dorsal plane of the base, narrowed somewhat posteriorly with a groove immediately behind the prominent molar which is a continuation of the ventral groove; right mandible with a broad cutting edge, the terebral margin more prominent than the underlying retinacular ridge, the terebral tooth broad and prominent, molariform, the molar area similar in shape to molar area of *latifrons,* the margin not widened as in the left mandible; hairs of the ventral groove shorter and sparser than in the other two types.

*Variations from the basic plans.*—

1. From the *polita* type.
   a. *D. daldorfi* Crotch (figs. 2a-e).
      Left mandible—terebral tooth represented by a very slight denticulation; retinacular ridge more prominent than in *polita,* not curving toward terebral margin about half-way between margin and terebral tooth but diverging, and extending almost to apex; retinaculum indicated by a low hump at posterior end of ridge; premolar tooth broad, in a horizontal plane; right mandible normal.
   b. *D. colossa* Bates (fig. 3).
      Left mandible—terebral tooth very prominent, with retinaculum well developed, retinacular ridge moderately well developed but terminating near dorsal angle of oblique apex. Right mandible normal.
2. From the *zeelandica* type.
   a. *D. cordicollis* Laferté (fig. 7).
      Left mandible—surface strigose, with a broad, fusiform premolar area, lying between terebral and retinacular margins; anteriorly, cutting edge is narrow and flat, not bev-

eled; no deep groove separating premolar process from molar. Right mandible—dorsal surface strigose.

b. *D. aegyptiaca* Dejean (fig. 8).
Left mandible—terebra broadly concave in vertical plane, laterad of cutting edge; cutting surface thin edged, composed of only retinacular ridge, terebral margin indicated only in basal portion of terebra, being dorsal margin of broad premolar, behind which is a deep groove, separating premolar area from molar.

c. *D. macromandibularis* Habu and Tanaka. (These observations are based on a study of good illustrations, not on examination of specimens).
Right mandible with outer margin strongly curved medially, apex nearly rectangular (but rounded), apical area much broader than apical area of left mandible. (See Habu, 1956: 63, figs. 3 and 4).

*Interpretation of the scutellar stria in Diplocheila.*—Certain details of arrangement of the innermost striae of the elytra are encountered and require some explanation (figs. 10, 11, and 12). On each elytron of most species of *Diplocheila* there are nine lines (eight striae, and the marginal groove looks like a stria) which either attain the apex or approach it closely. In some species there is a short scutellar stria between the first stria and the suture (fig. 10). In these species stria 1 arises basally from a puncture, from which stria 2 also arises. In other species there is no short scutellar stria between stria 1 and the suture, and stria 1 does not arise from the puncture at the base of stria 2 (fig. 12). In some specimens exhibiting this latter condition a broken line can be seen between the basal puncture and stria 1 (fig. 11). In specimens that appear to lack the scutellar stria, stria 1 is not straight but there is a short " jog " near the base of the elytron.

My interpretation of the above fact is that within the genus *Diplocheila* the primitive condition of the elytral striation is with stria 1 arising close to the base of stria 2, bending medially, then straightening and running to the apex of the elytron. The scutellar stria is short and free from stria 1. The derived condition results from a joining of stria 1 with the scutellar stria, and the atrophy of the oblique basal portion of stria 1. No evidence bears directly on this problem except

the small " jog " in the base of stria 1, in the derived condition, which is about at the right place to indicate the point of union of stria 1 with the scutellar stria. I suggest that the most primitive condition of the elytra is that in which each elytron has nine complete striae; and that the simplest derived condition is that in which the morphological first (scutellar stria) is shortened, the condition which is seen in some of the species of *Diplocheila*, in all of the species of *Dicaelus*, *Badister*, and *Licinus* in the Licinini as well as in most of the other licinine genera, in a large number of other carabid genera, as well as in other families.

These facts have been given a different interpretation by Sloane (1920: 113-114), and Jeannel (1941: 29-34). Both have concluded that rather than the scutellar stria shortening (morphological stria 1), stria 1 (morphological stria 2) has shortened, and when quite short has attached to the long scutellar stria near its base. Following this union the basal portion of morphological stria 1 has broken away from that portion which lies posterior to the juncture of morphological stria 1 with morphological stria 2. To support this interpretation, both Jeannel and Sloane figure series of elytra which supposedly show the transition stages. Both series begin with a migadopine (*Calyptogonia ater* Sloane and *Loxomerus nebrioides* Guer.) in which species stria 1 (morphological stria 2) is somewhat shortened. My system and theirs agree that the absence of the basal part of stria 1 (morphological 2) in *Diplocheila* is a derived condition. Study of the pupal elytra may possibly shed light on the developmental pattern of the elytral striae.

*Notes on the Classification of the Species of the Genus Diplocheila.* The species included within the limits of the genus are a morphologically rather diverse assemblage, differing from one another in a variety of characters (see keys).

The various supra-specific groups have been delimited on the basis of a combination of characters. Ball (1954: 53-59) presents details of how this classification was determined. A number of other arrangements were suggested, and refuted, in favor of the one presented here.

Jeannel (1949: 772) stresses the presence or absence of a basal striole (scutellar stria) in the first interstria as the principal character for defining units within the genus *Diplocheila*. His arrangement of species is quite different from the one used here, with the result that the subgenus *Isorembus*, proposed by him, is radically reconstructed.

A carefully executed, well-illustrated paper on the Japanese species of *Diplocheila* by Habu (1956) has recently come to my attention. Habu proposes an arrangement of the species different from the one used here, and proposes the new genus *Submera,* new subgenus *Submera,* for *zeelandica* and *latifrons,* and a new species, *macromandibularis* (new subgenus *Shirahataia*). He believes these species constitute a genus distinct from *Diplocheila* because they have two supraorbital setae over each eye, a deeply emarginate clypeus, and a labrum and mandibles which differ in shape from those of typical *Diplocheila.* However, as he did not have access to material other than Japanese, Habu could not know that *aegyptiaca,* the type of Jeannel's *Isorembus,* and *zeelandica,* the type of *Submera,* are more similar to one another than either is to *daldorfi,* the type of *Diplocheila.* (Incidentally, Habu states that *polita* is the type species of *Diplocheila,* but this is not correct). Thus, if the former two species are placed in a group other than *Diplocheila,* both must either be included in the same group, or two groups of equal status must be proposed for these species. If the first alternative is accepted, then *Isorembus* must be accorded generic status, provided that *Submera* is regarded as a genus. I prefer to place both in the same taxon, namely *Isorembus.*

I believe *Isorembus, Diplocheila* (*s. str.*) (and *Neorembus*) should be treated as subgenera of a single genus because these groups of species are more closely related to one another than they are to anything else in the Licinini, and, furthermore, the " morphological gap " that separates them is a relatively narrow one compared to that which separates each from *Dicaelus,* the other member of the First Group of licinine genera.

As was noted above, Habu places *latifrons* and *zeelandica* in the same supraspecific taxon, but I think that *latifrons* differs sufficiently in the shape and structure of its mandibles from both *Diplocheila* and *Isorembus* to warrant a group of its own which is of the same rank accorded the former. Actually, this species possesses a combination of the diagnostic features of *Diplocheila* and *Isorembus:* edentate mandibles and narrow lobes of the labrum, as in *Isorembus;* long setae in the ventral groove, the mandibles, symmetrical labrum and convex front of the head, as in the species of *Diplocheila* (*s. str.*).

I think that the species *macromandibularis* is too similar to the members of the *zeelandica* group to be placed in any other group.

*Location of type specimens.*—Andrewes (1930: 148-151) gives the present location of all the type specimens of Indian species of *Diplocheila* known to him.

Subgenus **Diplocheila** (*s. str.*) Brullé

*"Rembe"* Latreille and Dejean, 1822: 85; [a brief diagnosis is given and two species are included: *Carabus indicus* Herbst, and *Carabus politus* Fab.]; [vernacular name!].

*Rembus* Dejean, 1826: 380; [two species included: *Carabus politus* Fab., and *Carabus impressus* Fab.].

*Diplocheila* Brullé, in Audouin and Brullé, 1834: 407; ["These insects have received the name *Rembus* by Latreille, but since it has been applied previously by M. Germar, 1824, to a genus of curculionids, we have substituted *Diplocheila* for it"—translation].

*Diplocheilus* Westwood, 1838: 5; [for *Diplocheila* Brullé].

GENOTYPE: *Carabus impressus* Fab., 1792; (subsequent designation by Westwood, 1838).

*Diplochila* L. Agassiz, 1846; [emendation for *Diplocheila* Brullé].—Andrewes, 1919: 20; [regarding Bonelli's Tableau Synoptique Andrewes says: "There is also a blank space for an unnamed genus formed for *Carabus impressus* Fabr.; this would, I suppose, be *Diplochila* Brullé, (*Rhembus* Dejean, *nom. praeo*), and why Bonelli failed to give it a name I do not know."].

*Eccoptogenius* Chaudoir, 1854: 320.—Andrewes, 1921: 590; [notes that *Eccoptogenius* is synonymous with *Diplocheila* Brullé].

GENOTYPE: *Eccoptogenius moestus* Chaudoir, 1852 [= *Rembus distinguendus* Laferté, 1851]; (Monobasic).

*Symphyus* Nietner, 1858: 180.

GENOTYPE: *Symphyus unicolor* Nietner, 1858 [= *Carabus politus* Fab., 1792]; (Monobasic).

*Rhembus* Gemm. and Harold, 1858: 238; [emendation for *Rembus* Latr.].

Although the name *Rembus* is in common use for this genus at present, *Diplocheila* is correct, as Andrewes (1939: 133) points out. Jeannel (1949: 771) gives the date of the name *Rembus* Latreille as 1817, and then gives a page and figure reference (Vol. I, p. 150, Pl. 23, fig. 9) which seems to be from the Disciples' Edition of "Le Regne Animal". The probable date of publication of the section containing page 150 is 1843, according to Sherborn (1922: 556). Jeannel's reference, therefore, has no meaning in establishing the priority of *Rembus* over *Diplocheila*. Ball (1954: 62-64) discusses this problem in detail.

*Diagnostic Features.*—The most important distinctive features of this subgenus are these: supraorbital setigerous punctures 1 or 2; front flat, except for frontal impressions, not depressed medially, clypeus flat, about 1.5 times wider than labrum, anterior margin varying from slightly to deeply emarginate; labrum wider than long, anterior margin broadly emarginate, base of emargination angulate or rounded, lobes approximately symmetrical and of equal size, apices broadly rounded to subtruncate; mandibles of the *politus* type, as described above; prosternum not margined apically between the front coxae; basal portion of stria 1 either present or absent; setae on 6th abdominal sternite, two in males, four in females; rectractile stylus of female either short and broad or more elongate, apex variable in shape, margins with a variable number of setae.

*Distribution.*—The species included in this subgenus are for the most part Oriental in distribution, with one species ranging along the eastern edge of the Palaearctic Region, extending northward to Japan.

### *Key to the Species of Subgenus Diplocheila*

1. Head with one supraorbital setigerous puncture over each eye, labrum quadri- or sexsetose, scutellar stria present, and not joined to stria 1, stria 1 having a common origin with stria 2, integument of dorsal surface not micropunctulate ..... *polita* group 2

   Head with two supraorbital setigerous punctures over each eye, labrum quadrisetose, scutellar stria present, joined to the sutural portion of stria 1, basal portion of stria 1 completely or partially atrophied, integument of dorsal surface micropunctulate ..... *daldorfi* group 8

2. Labrum quadrisetose (some specimens with 5 setae), lobes short, emargination moderately deep, clypeus moderately to shallowly emarginate (cf. figs. 17a and b) ..... 3

   Labrum with six setae on dorsal surface, lobes longer, clypeus moderately to deeply emarginate (cf. figs. 18a and b, and fig. 19) ..... 6

3. Antennal scape normal, not clavate, of average length (max. L labrum/L ant. seg. 1, 0.55 or more) ..... 4

   Antennal scape clavate, longer than usual (max. L labrum/L ant. seg. 1, less than 0.55) ..... *D. distinguenda* Laf.

4. Length less than 20 mm., labrum relatively shallowly or moderately deeply emarginate, base of emargination rounded or angulate ..... 5

   Length greater than 20 mm., labrum relatively shallowly emarginate (labrum: max. L/min. L, 1.85), base of emargination broadly rounded *D. elongata* Bates

5. Hind angles of pronotum well formed, flaring out slightly, labrum relatively shallowly emarginate (max. L/min. L, less than 2.50), lines of macrosculpture on lateral thoracic sclerites fine, the surface shining *D. quadricollis* Laf.

Hind angles of pronotum not produced, labrum relatively deeply emarginate (max. L/min. L, 2.50 or more), lines of macrosculpture on lateral thoracic sclerites coarser, surfaces opaque ..... *D. polita* Fab.

6. Clypeus deeply emarginate (W/median L, greater than 4.50), labrum deeply emarginate (W/median L, greater than 6.50), pronotum with base relatively wide (L/W base, less than 0.95) ..... 7

Clypeus emarginate, but less deeply so, exposing only a narrow band of labral membrane (W/median L, less than 4.50), labrum usually less deeply emarginate (W/median L, less than 7.56), pronotum with base relatively narrow (L/W base, 0.95 or more), hind angles not produced (figs. 29 and 30) ..... *D. laevigata* Bates

7. Sides of pronotum slightly sinuate in front of hind angles, the latter therefore slightly produced (fig. 28), lobes of labrum longer on the average (max. L/min. L, greater than 3.80) ..... *D. indus* Dejean

Sides of pronotum not sinuate in front of hind angles, the latter obtusely angulate, not produced (fig. 31), labral lobes shorter on the average (max. L/min. L, less than 5.80) ..... *D. laevigatoides* Jedl.

8. Elytra with striae normally impressed ..... 9

Elytra with striae shallowly impressed, smooth and shining *D. exotica* Andr.

9. Pronotum strongly narrowed anteriorly, apex appearing narrower than base (fig. 24), labial palpus of the male with apical segment only slightly dilated, nearly three times longer than wide, labrum deeply emarginate, retinaculum of the left mandible very small, terebral tooth little developed (fig. 2a) ..... *D. daldorfi* Crotch

Apex of pronotum only moderately narrowed, appearing only slightly or not at all narrower than base, labial palpus of male with apical joint rather strongly dilated, less than twice as long as wide, labrum only moderately deeply emarginate, teeth of left mandible well developed (fig. 3) *D. colossa* Bates

### *daldorfi* group

In addition to the characters presented in the key, the members of this group may be differentiated from members of the *polita* group by the possession of more slender mandibles, and by the shape of the 8th sternite in the female (fig. 49), the membranous portion of which is moderate in size, constricted toward the median line, and widened laterally.

These species are morphologically closer to one another than to any other species but they are not equally similar. *Daldorfi* differs appreciably from *colossa* and *exotica* in shape of the retractile stylus and in mandibular structure.

This group ranges from India through Burma eastward to Indo-China and the Philippine Islands, and southward and eastward in the Malay Archipelago to Sumatra.

**Diplocheila** (*s. str.*) **daldorfi** Crotch

*Carabus impressus* Fab., (not Panzer, nor Oliver), 1798: 57.—Ibid., 1801: 188.
*Rembus impressus* Dejean, 1826: 383.—Laferté, 1851: 279.
*Rhembus impressus* Bates, 1892: 326.—Andrewes, 1919: 90.—Ibid., 1921: 159.
*Diplocheilus impressus* Westwood, 1838: 5.
*Diplocheila impressa* Hope, 1838: 81.
*Rembus daldorfi* Crotch, 1870: 9.—Csiki, 1928–1931: 1001.

*Description.*—Male. Pusa, Bengal, Agricultural Research Institute (H. E. Andrewes Coll.), (*Rhembus impressus* Fab., det. Andrewes), (British Mus. N. H.). Length 21.4 mm., width 9.3 mm. Sculpture as described for genus, lines of macrosculpture fine, thoracic episterna and lateral areas of pro- and metasternum microgranulate, crossed transversely by fine lines.

Frontal impressions of head elongate irregular basins, diverging posteriorly. Clypeus transverse, 4.76 times wider than long, anterior margin medially moderately concave exposing basal membrane of labrum, 1.40 times wider than labrum. Labrum 1.93 times wider than long, lobes long, symmetrical, broadly rounded apically, emargination broad and deep, weakly angulate at base, maximum length 9.67 times greater than minimum length, quadrisetose. Mandibles symmetrical, except left has three teeth and right only a single tooth (figs. 2a-e). Pronotum as in fig. 24 not strongly declivous laterally; base noticeably broader than apex, median longitudinal impression shallow, anterior and posterior transverse impressions not apparent, posterior lateral impressions linear, short, deep, each in a rather elongate, narrow basin, removed by about their length from the posterior margin; lateral margins bordered by a groove; metepimeron obliquely truncate in lateral one-half of posterior margin, not broadly rounded.

Elytra broadly convex, striae distinctly impressed.

Median lobe of male genitalia as in fig. 70.

Female. Pachrukhi, Behar, India, 1927, Cornell U. Lot No. 753, (Cornell University). Agrees with the male in all essential details. Eighth sternite as in fig. 49. Retractile stylus as in fig. 55.

*Synonymical Notes.*—The name *Carabus impressus* Fab. is a junior homonym of *C. impressus* Panzer and *C. impressus* Olivier. Thus Crotch (1870) proposed the new name *Rembus daldorfi,* honoring the donor of one Fabrician type specimen, " Dom. Daldorf ".

*Distribution.*—This species ranges from Ceylon (Kandy) and throughout peninsular India to at least 28° N. lat. (Chapra, in Rajputana), eastward through Burma to Cochin China and southward to Singapore, in Malaya. See Andrewes (1930: 149) for specific localities.

**Diplocheila** (*s. str.*) **colossa** Bates

*Rhembus colossus* Bates, 1892: 326. Type locality: Pelon (Pegu).
*Diplocheila colossa* Andrewes, 1922: 285 and 286.—Ibid., 1930: 149.
*Rhembus impressus* Redtenbacher (not Fabricius), 1847: 10.—Andrewes, 1923 (1924): 464; (establishes synonymy presented here).

The emargination of the clypeus is shallower and more angular than in *daldorfi* (fig. 14a). The labral emargination is shallower than in *daldorfi*, broadly rounded basally; lobes shorter and broader apically than in *daldorfi* and *exotica* (fig. 146). The pronotum is less narrowed apically and more rounded basally than in *daldorfi* (fig. 25). The body surface is more glossy than in *daldorfi*, but less so than in *exotica*.

*Description.*—Male. Haut Mekong, Vien Poukha, 3.V.1918, (R. V. de Salvaza), (det. H. E. Andrewes—comp. with type), (British Mus. N. H.). Length 24.2 mm., width 10.1 mm. Sculpture as described for genus and for *D. daldorfi*.

Frontal impressions of head relatively small and shallow. Clypeus 2.88 times wider than long, as in fig. 14a, exposing basal membrane of labrum. Labrum 2.50 times wider than long, as in fig. 14b, 4.50 times greater than min. L, max. L 1.67 times greater than min. L. Mandibles slightly asymmetrical, left as in fig. 3. Right mandible similar to left, dorsal surface slightly declivous basally, terebral tooth abruptly and clearly marked off on its basal side, but only slightly higher than elevated terebral margin anteriorly, dorsal surface abruptly narrowed in front of tooth.

Pronotum as in fig. 25, disc flat, declivous laterally, flattening in posterior lateral areas; median longitudinal impression fine, transverse impressions not apparent; posterior lateral impressions linear, removed by their length from posterior margin; metepimeron with posterior margin broadly rounded medially, becoming sinuate laterally.

Elytra with basal portion of stria 1 indicated by a series of punctures, not connected to sutural portion of 1; striae 1-7 equally and distinctly impressed, very finely punctate toward base.

Median lobe of male genitalia as in fig. 71.

Female. In collection of Museum of Comparative Zoology, agrees with male in important features. Eighth sternite as in *D. daldorfi*. Stylus as in fig. 25.

*Distribution.*—This species ranges from Lower Burma (Rangoon), eastward to Indo-China, southward in the Malay Archipelago to Sumatra, and in the Philippine Islands. For specific localities see Andrewes (1930: 149).

**Diplocheila** (*s. str.*) **exotica** Andrewes

*Diplocheila exotica* Andrewes, 1931: 66, [type specimen a male, in Andrewes Coll., British Mus. N. H.]. Type locality: Sumatra, Djambi; (determined from original description).

This species differs from *daldorfi* in having a slightly shallower clypeal and labral emargination (fig. 15), and the pronotum narrowed less apically, and more basally. The characters distinguishing *exotica* from *colossa* are: labral lobes longer, and labral emargination deeper and more angular basally.

*Description.*—Female. E. Sumatra, Reoiuw. Res. Inderagin Rengat, 15.V.1939, (det. C. J. Louwerens). (Museum of Comparative Zoology). Female. Length 21.7 mm., width 9.1 mm. Surface shining, glossy. Macrosculpture normal for genus, but lines finer than average. Frontal impressions of head small, punctiform, not attaining plane of anterior pair of supraorbital setigerous punctures. Clypeus slightly declivous, 1.60 times wider than labrum, 3.96 times wider than long, as in *colossa*. Labrum 2.04 times wider than long, as in fig. 15, width 5.20 times greater than min. L, max. L 2.45 times greater than min. L. Mandibles as in *colossa*. Segments of maxillary palpus slender, elongate, terminal segments truncate apically. Terminal segment of labial palpus slightly widened.

Pronotal shape as in *colossa*. Elytra as in *colossa*, striae fine, shallow, very finely and shallowly punctate, intervals flat.

Eighth sternite and retractile stylus as in *colossa*.

*Distribution.*—This species is known only from Sumatra.

## *polita* group

In addition to the characters presented in the key, members of this group may be distinguished from members of the *daldorfi* group by the mandibles which are broader apically, and by the shape of the 8th sternite of the female (fig. 48). This latter structure has the lateral margin straight beneath the deep more anterior notch, the membranous portion is larger, and the margin beneath the membranous portion is more sharply turned anteriorly.

As the surface sculpture of all of the species of this group is about the same, variation occurring only in depth of the lines, the surface markings are described here instead of repeating the same description for each species.

Surface generally shining, head and pronotum more glossy than elytra; microsculpture forming slightly transverse meshes on head, clypeus, labrum and

pronotum, lines very fine on head, fine on other structures; meshes weakly transverse on lateral and ventral thoracic sclerites and abdominal sternites. Macrosculpture: head-postorbital area crossed transversely by a series of shallow lines, interorbital area laterally with several fine oblique lines, terminating in frontal impressions, frontal area with or without transversely directed lines; genal lines obsolescent, head ventrally with a series of transversely directed lines; pronotum medially with fine transverse lines, becoming obsolescent laterally, except posteriorly in the vicinity of posterior lateral impressions where they are deeper; prosternum medially crossed by a series of fine lines, rugulose laterally, lateral thoracic sclerites rugulose, crossed transversely by a series of zig-zag lines, prosternum and metasternum smooth medially; abdominal sternites smooth medially, rugulose laterally, with fine longitudinal lines.

The seven known members of the *polita* group seem to fall into two arrays, with two species more or less intermediate in position. One includes *elongata, distinguenda,* and *quadricollis.* These three species share in common a relatively transverse labrum with short lobes and bearing four setigerous punctures. The anterior margin of the clypeus is very shallowly concave, exposing a very narrow band of labral membrane, and the ventral surface of the median lobe of the male genitalia is arcuate. The second array includes *indus,* and *laevigatoides.* These two species have a more quadrate labrum, with longer lobes, and bearing six setigerous punctures. The anterior margin of the clypeus varies from moderately to deeply emarginate, and the ventral surface of the median lobe is flat, not arcuate. *Diplocheila polita* seems to fall between these two arrays but closer to the *quadricollis* complex, its labrum quadrisetose, the lobes moderately elongate, the clypeus moderately deeply emarginate, and the ventral surface of the median lobe arcuate. *Laevigata* is closer to *indus* and its morphological associate, *laevigatoides,* for the labrum is sexsetose, the lobes on the average slightly longer than in *polita,* and the clypeus moderately deeply emarginate. The ventral surface of the median lobe is not arcuate.

Two specimens make it virtually impossible to arrive at a good classification of these species at this time. These are discussed at the end of this section.

The *polita* group is widespread in the Oriental Region, ranging from Ceylon and throughout peninsular India eastward through Burma and Indo-China to Borneo and Java in the Indo-Australian Archipelago, and the Philippine Islands and Formosa, and Japan, and on the mainland northward at least to the latitude of the Yang-tse Kiang (Kiu

Kiang). Species of the "*quadricollis* complex" are not known to occur in the Philippines or in the Indo-Australian Archipelago. The "*indus* complex" does not range into southern India, but occurs in the Philippines and Indo-Australian Archipelago. *Laevigata* is found in Indo-China and Burma, and *polita* ranges throughout southeast Asia.

**Diplocheila** (*s. str.*) **polita** Fabricius

*Carabus politus* Fab., 1792: 146. Type locality: "India orientale", (Dom. Lund).—Ibid., 1801: 189.—Habu, 1956: 51.

*Diplocheila polita* Brullé, 1834: 408, t. 16, f. 6.—Motschulsky, 1855: 62.—Andrewes, 1921: 155.—Ibid., 1930: 151.

*Symphyus unicolor* Nietner, 1858: 180. Type locality: Colombo, Ceylon (determined from original description).—Motschulsky, 1862: 55.—Andrewes, 1927: 105.

*Platysma retinens* Walker, 1859: 51. Type locality: Ceylon (determined from original description).—Andrewes, 1919: 193.

*Eccoptogenius retinens* Bates, 1886: 212.

*Rhembus rectificatus* Bates, 1891: CCCXXIX.—Ibid., 1892: 325.—Andrewes, 1919: 193.—Ibid., 1921: 155.

*Diplocheila distinguenda* Andrewes (not Laferté), 1919: 193.—Ibid., 1921: 147.

*D. polita* resembles *laevigata* in external appearance, differing in having only four setae on the labrum, and the labrum on the average less deeply emarginate. The stylus of the female retractile plates is quite similar to that of *elongata*, *distinguenda*, and *laevigatoides*, and the median lobe of this species is like that of *quadricollis* and *distinguenda*.

*Variation.*—Data on variation in the following measurements and ratios are presented in Tables 2-9: total length, maximum width, clypeus: W/L, labrum: max. L/min. L, labrum: W/min. L, max. L labrum/L ant. seg. 1, PN: W wp/L, and PN: L/W base. There is a moderate amount of variation in the macrosculpture, lines on the pronotum vary from fine to moderately coarse on the median portion of the disc. The lateral and ventral thoracic sclerites and venter exhibit slight variation in sculpture. The frontal impressions of the head vary somewhat in shape, extent, and depth. The clypeus is shallowly emarginate in all specimens examined, but more deeply so than in *quadricollis* and *distinguenda*. The base of the labral emargination is either angulate or narrowly rounded. The lobes vary in length somewhat, but are longer than in *quadricollis* and *distinguenda*, and shorter than in *indus*.

The antennal scape is normal, not clavate. The pronotum (fig. 26) varies slightly in shape, the sides being more or less broadly rounded, the posterior angles more or less prominent, but less so than in *indus,* in all specimens studied. The elytral striae are finely punctate in all specimens studied. One male from Kurumbagaram and one female from Coimbatore each have a single extra seta on the labrum, located on the left lobe about half-way between the apex and the basal setigerous puncture.

There is no appreciable variation in the 8th sternite of the females, nor in the shape of the retractile stylus (fig. 54).

Median lobe of male genitalia as in fig. 72.

*Distribution.*—This species is reported by Andrewes (1930) to range throughout India, Ceylon, and Burma.

Seventeen males and eleven females from the following localities have been examined and dissected.

India: Calcutta, Coimbatore, Kurumbagaram, Karikal Terr., Madras, Nedungadu, Rajmahal.

**Diplocheila** (*s. str.*) **quadricollis** Laferté

*Rembus quadricollis* Laferté, 1851: 279. Type locality: "Ind. Or." (determined from original description).
*Diplocheila quadricollis* Andrewes, 1930: 151.

The sharper and more flaring posterior angles of the pronotum distinguish this species from those which it most closely resembles (fig. 27), and are reminiscent of *indus.* However, the latter species has the body surface more coarsely sculptured, longer labral lobes, and a more deeply emarginate clypeus. The retractile stylus is distinctive (fig. 58). The proportions of the labrum of *quadricollis* are similar to those of *distinguenda.*

*Variation.*—Data on variation in the following mensural characters and ratios are presented in tables 2-9—total length, maximum width, clypeus: W/L, labrum: max. L/min. L, labrum: W/min. L, max. L labrum/L ant. seg. 1, PN: W wp/L, and PN: L/W base. The head in three of the specimens examined is virtually smooth, with only two lines in the interorbital area. The fourth specimen has a shallow transverse line behind the eyes. The antennal scape is normal, not clavate. The shape of the pronotum is constant, with the posterior lateral angles

prominent. The elytral striae are finely punctate in all specimens examined.

The apex of the female stylus may be slightly more broadly rounded than in fig. 58, and the outer margin may have two short spines.

The median lobe of the male genitalia is like that of *polita*, but the ventral margin is very strongly bulging.

*Distribution.*—This species probably ranges throughout India. I have seen and dissected one male and three females, collected in the following localities.

INDIA: Madras, Nedungadu.

**Diplocheila** (*s. str.*) **distinguenda** Laferté

*Rembus distinguendus* Laferté, 1851: 278. Type locality: "Ind. bor." (determined from original description).—Andrewes, 1921: 147.—Ibid., 1924: 590.
*Diplocheila distinguenda* Andrewes, 1930: 149.
*Eccoptogenius moestus* Chaudoir, 1852: 74.—Andrewes, 1921: 147.

The clavate antennal scape immediately distinguishes this species from all other members of the *polita* group. The styli of the female retractile plates are most like those of *laevigatoides* (see fig. 58, cf. fig. 63). The median lobe of *distinguenda* is indistinguishable from that of *polita* and *elongata*.

*Variation.*—Data on variation in the following mensural characters and ratios are presented in tables 2-9—total length, maximum width, clypeus: W/L, labrum: max. L/min. L, labrum: max. W/min. L, max. L labrum/L ant. seg. 1, PN:W wp/L, and PN: L/W base. There is slight variation in the depth and distinctness of the lines of macrosculpture on the pronotal disc.

The median lobe of the male genitalia is shaped as in *polita* except that the apex is acute.

*Distribution.*—This species is known only from India. I have seen and dissected three males and ten females from the following localities.

INDIA: Kurumbagaram, Karikal Terr.; Nedungadu; Purneh District (det. Andrewes *Eccoptogenius distinguendus* Laf.).

**Diplocheila** (*s. str.*) **elongata** Bates

*Rembus elongatus* Bates, 1873: 256. Type locality: Hiogo, Japan (determined from original description). Habu, 1956: 53, figs. 1, 9, 20, 24, 27.
*Diplocheila elongata* Andrewes, 1930: 149.

This species differs from *quadricollis* and *distinguenda* in that the base of the labral emargination is rounded and not angulate (fig. 17). The apex of the female retractile stylus is broadly and squarely truncate.

*Description.*—Male. Nora, Japan, 25:VI.1, VII.81, 1910: 320 (G. Lewis), (British Mus. N. H. Coll.).

Length 20.6 mm., width 7.9 mm. Surface shining, head, pronotum, and elytra equally glossy. Sculpture normal for group.

Frontal impressions of head deep and linear, convergent, not extending posteriorly to equator of eye, genal striae present and shallow. Clypeus 2.85 times wider than long, 1.33 times wider than labrum, anterior margin very shallowly and broadly concave, almost straight. Labrum transverse, 2.66 times wider than long, W 5.33 times greater than min. L, lobes short and broad, right slightly wider than left, broadly rounded apically, emargination broadly rounded at base. Mandibles as in *polita*. Antennal scape normal, not clavate.

Pronotum as in *polita*. Elytra with striae moderately deeply impressed, finely and closely punctate.

Male genitalia, median lobe as in *polita*.

Female (Museum of Comparative Zoology). Agrees with male in all details. Female stylus as in fig. 60.

*Distribution.*—Andrewes (1930) records this species from China, Japan and Formosa.

**Diplocheila** (*s. str.*) **indus** Dejean

? *Carabus indicus* Herbst, in Fussely, 1874: 138, t. 29, f. 11.—Latreille, in Cuvier, 1817: 196.—Chaudoir, 1852: 67.—Andrewes, 1919: 144.—Ibid., 1927: 98.

*"Rembe" indicus* Latreille and Dejean, 1822: 85.

*Pterostichus indus* Dejean, 1821: 12; (*nomen nudum*). Type locality: "Indes Orientales" (Westerman and Gyllenhal)) (determined from original description).

*Rembus indus* Dejean, 1826: 381.

*Rembus politus* Dejean (not Fabricius), 1826: 381.—Laferté, 1851: 279, (Java).

*Rembus subpunctatus* Laferté, 1851: 279; **New Synonymy.** Type locality: "India Or." (determined from original description).

*Rhembus politus* Bates, 1892: 325.

*Omaseus herbstii* Dejean, 1826: 381.

*Diplocheila percissa* Andrewes, 1921: 156.—Ibid., 1922: 283.—Ibid., 1930: 151.

*Diplocheila subpunctata* Andrewes, 1930: 151.

A combination of prominent posterior pronotal angles, deeply emarginate, sexsetose labrum, and deeply emarginate clypeus sets this species off from other members of the *polita* group (figs. 18 and 28). The retractile stylus of *indus* most closely resembles that of *laevigatoides* (fig. 61, cf. fig. 63).

*Variation.*—Data on variation in the following mensural characters and ratios are presented in Tables 2-9—total length, maximum width, clypeus : W/L, labrum : max. L/min. L, labrum : W/min. L, max. L labrum/L ant. seg. 1, PN : W wp/L, and PN : L/W base. The lateral and ventral thoracic sclerites are less rugulose in a specimen from Jorhat than in one from Pusa. Of two specimens from Rajmahal, the female has the lines on the head deeper than in a specimen from Pusa, the frontal impressions are more rugulose, longer and deeper, and there is a shallower impression medially on the front. The male has the lines of macrosculpture shallower than in the Pusa specimen, the median impression on the front is very shallow. The frontal impressions of the Jorhat male are deeper and more rugulose than in the Pusa specimen, but the lines on the rest of the head are finer and shallower than in the latter. There is slight variation in the depth of the emargination of the clypeus. The Jorhat specimen has much shorter labral lobes (labrum : max. L/min. L-3.84) than the others. The concavity in the anterior margin of the pronotum is shallow in the Rajmahal specimens, deeper in the Pusa specimen, and deeper still in that from Jorhat. The elytral striae are shallowly punctate in all specimens examined.

The retractile stylus does not exhibit any appreciable variation in two females.

Median lobe of male genitalia as in fig. 74, and exhibits, in ventral aspect, no variation (three males dissected and studied).

*Synonymical Notes.*—The nomenclatorial problem involved in this species has arisen due to a misidentification on the part of Dejean (1826), and to a possible oversight on the part of Andrewes (1921).

Dejean, in 1821, proposed a name, *Pterostichus indus,* for a carabid, but did not include a description with it. Subsequently, in 1826, under his description of *Rembus politus* Fab., he listed his *Pter. indus* as a synonym, as well as the name *Omaseus herbstii* Megerle. This latter name, probably a label name, was appended to a specimen which he received from the Vienna Museum. Laferté (1851) points out that Dejean had included three species under the name *R. politus* Fab., as follows: 1. A specimen in which the elytral striae are impunctate, and whose posterior thoracic angles are not prominent, and which is known only from Java. This specimen Laferté referred to *polita* Fab. 2. A specimen which Dejean had named *Pterostichus indus* in 1821 and

which was later united with *politus* as a doubtful variety. This variety has the elytra feebly punctate, and the pronotum is sinuate at the sides, with the posterior angles slightly prominent, not rounded. This species is known from India, and Laferté, regarding it as different from the Java *politus*, named it *subpunctatus* in spite of the fact that it already bore the name *indus*. 3. Finally, the third species, which is also Indian, has the clypeus not emarginate, and Laferté named this specimen *distinguendus*. We are concerned here only with *indus* Dejean, and from the above it may be concluded that *subpunctatus* is a synonym of it by Laferté's own admission.

Andrewes (p. 156, 1921), after having examined the types of *Carabus politus* Fab. and *Rembus politus* Dejean, concluded that the two were different. Apparently unaware that Dejean's type series contained two different entities in addition to *distinguendus* Laferté, he proposed the name *D. percissa* for Dejean's concept of *polita* Fab. Since these entities, according to Laferté, were in the Dejean *politus* series, the problem arises as to which specimen Andrewes wished to apply the name to. I have seen one specimen determined by Andrewes as *percissa*. This specimen agrees in pronotal shape with *indus* Dejean, as described by Laferté. On the basis of this specimen I place the name *percissa* Andrewes in the synonymy of *indus* Dejean. The other possible solution would be to use the name *percissa* for Java specimens having impunctate elytral striae, posterior angles of the pronotum not prominent, and with labrum and clypeus deeply emarginate. The only specimens from Java seen in this study which have the above combination of characters are referable to the species *D. laevigatoides* Jedlicka, although they may be subspecifically different from typical *laevigatoides*. If, indeed, the Java specimen in Dejean's series referred to as *percissa* by Andrewes really is *laevigatoides*, and if my arbitrary type designation for *percissa* is not accepted, then the name *percissa* may be used for the specimens included here in the species *laevigatoides*, and the latter name would then be treated as a synonym of *percissa*.

To return to *indus*, Chaudoir, in 1852, indicated that he considered *Carabus indicus* Herbst as synonymous with *Rembus politus* Dejean. Andrewes (1927) cites this fact and then says that Chaudoir did not give reasons for his conclusion, and that the name *indicus* Herbst should be abandoned because it cannot be applied with certainty to any

species of *Rembus*. Until the type specimen of *indicus* is studied I accept Andrewes' opinion. However, the Dejean name *Rembus indus*, 1826, is available and valid and, therefore, this name should be used for the specific entity in question.

*Distribution.*—This species ranges from peninsular India eastward to Burma, and Java, in the Indo-Australian Archipelago. Andrewes (1930: 150) gives a number of locality records.

Three males and two females from the following localities have been examined.

INDIA: Jorhat, Pusa, Rajmahal.

**Diplocheila** (*s. str.*) **laevigata** Bates

*Rhembus laevigatus* Bates, 1892: 326. Type locality: Kawkareet (determined from original description).—Andrewes, 1921: 177.—Ibid., 1922: 282 and 286.
*Rembus politus* Macleay (not Fab.), 1825: 16.—Redtenbacher, 1867: 10.—Lesne, 1904: 72.—Andrewes, 1919: 144.—Ibid., 1923 (1924): 463.
*Eccoptogenius moestus* Bates (not Chaudoir), 1899: 267.—Andrewes, 1921: 176.
*Diplocheila laevigata* Andrewes, 1930: 150.

This species is most likely to be confused with *laevigatoides*, but may be distinguished from that species by its narrower pronotum (figs. 29 and 30; cf. fig. 31) and the more shallowly emarginate labrum and clypeus.

*Variation.*—Data on variation in the following mensural characters and ratios are presented in tables 2-9—total length, maximum width, clypeus: W/L, labrum: max. L/min. L, labrum: W/min. L, max. L, labrum/L ant. seg. 1, PN: W wp/L, and PN: L/W base. Two specimens, one from Cochin-China and one taken at Hoah-Binh, Tonkin, males, are smaller in size than the others (12.8 mm. and 13.2 mm.), have the sides of the pronotum less strongly arcuate than in a female from Xieng Khouang, and the anterior margin more deeply concave. The base of the labral emargination is usually broadly rounded, as in the Xieng Khouang specimen, but varies to slightly angulate. Elytral striae 1-7 are punctate in two specimens from Xieng Khouang, Laos, and in one male, collected in Tonkin, and impunctate in the other specimens studied.

Male genitalia, median lobe as in fig. 75. No appreciable variation was observed. Retractile stylus as in fig. 62.

*Distribution.*—This species ranges from western Burma eastward to Indo-China, and possibly Java, Sumatra, and Borneo in the Indo-Malayan Archipelago, and the Philippine Islands. I believe that the islandic records for this species refer to *laevigatoides* Jedl. Andrewes (1930: 149) lists a number of localities for this species.

I have seen and dissected four males and two females from the following localities.

Indo-China: Laos; Xieng Khouang. Tonkin. Cochin-China.

**Diplocheila** (*s. str.*) **laevigatoides** Jedlička

*Diplocheila laevigatoides* Jedlička, 1936: 92; [type specimen in British Museum, paratype in Jedlička collection]. Type locality: Manila, Luzon, Philippine Islands (determined from original description).

*Diplocheila laevigata* Habu (not Bates), 1956: 55, figs. 2, 11, 21.

The deeply emarginate labrum and deeply emarginate clypeus (fig. 19) distinguishes this species from all other species of the *polita* group except *indus*, and pronotal shape separates *laevigatoides* and *indus*, (fig. 31; cf. fig. 28).

*Variation.*—The series of specimens representing *laevigatoides* has been treated as two entities for the presentation of mensural data because the specimens are from two different islands—Luzon, and Java—and, further, these groups differ in size and in the setae on the female stylus.

A summary of these data are presented in tables 2-9 for the following measurements and ratios—total length, maximum width, clypeus: W/L, labrum: max. L/min. L, labrum: W/min. L, max. L labrum/L ant. seg. 1, PN: W wp/L, and PN: L/W base. The surfaces of one specimen from Luzon and one from Java are more glossy than in the remaining specimens. Depth of the macrosculpture lines varies slightly. The frontal impressions are shallow basins, conspicuously smaller in a specimen from Luzon, conspicuously larger and deeper in a specimen from Java. All specimens examined have a small depression on the front, immediately behind the clypeus. Two specimens from Luzon have the elytral striae punctate. Five specimens from Luzon have at least one puncture in interval 3 on both sides. Two specimens from Luzon, and the Java series lack punctures in the intervals.

In one Luzon specimen there are two instead of three spines on the outer margin of the retractile stylus. In the specimens having three spines, the basal most is finer than the more apical pair. In the Java series one specimen bears four spines on the outer margin instead of three, the fourth smaller than average. In the specimens having three spines all are about of the same size.

Male genitalia, median lobe as in fig. 76 (cf. fig. 74). There is no appreciable variation (4 males dissected and studied).

*Synonymical Notes.*—Habu's illustrations (1956) suggest that the specimen which he regards as *laevigata* is actually a member of *laevigatoides.*

*Distribution.*—This species is known from the Philippine Island of Luzon, and from Java. Andrewes' records of *laevigata* from Sumatra and Borneo may also refer to this species.

I have seen and dissected four males and eight females from the following localities.

LUZON: Central Plains of Luzon. JAVA: "Java"; Toeloengagoeng. ? JAPAN (see Habu, 1956: 52).

TABLE 2

*Diplocheila polita* group: VARIATION IN TOTAL LENGTH (MM.).

| Species | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | N | Range | Mean | N | Range | Mean |
| *polita* | 17 | 13.4–17.2 | 15.2 | 11 | 13.5–18.4 | 16.0 |
| *quadricollis* | 1 | 15.0 | | 3 | 13.4–15.4 | 14.4 |
| *distinguenda* | 3 | 13.6 | 13.6 | 9 | 13.6–15.4 | 14.6 |
| *elongata* | 1 | 20.6 | | | | |
| *indus* | 3 | 14.0–15.1 | 14.4 | 2 | 16.4–16.5 | 16.45 |
| *laevigata* | 4 | 13.2–16.0 | 14.7 | 2 | 15.9–16.1 | 16.0 |
| *laevigatoides* (Philippines) | 3 | 13.2–15.9 | 14.9 | 4 | 14.3–15.9 | 15.1 |
| *laevigatoides* (Java) | 1 | 15.4 | | 4 | 17.4–19.8 | 19.8 |

TABLE 3

*Diplocheila polita* group: Variation in Maximum Width (mm.).

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *polita* | 17 | 5.6–7.0 | 6.4 | 11 | 5.9–7.8 | 5.7 |
| *quadricollis* | 1 | 6.0 | | 3 | 5.4–6.0 | 5.7 |
| *distinguenda* | 3 | 5.4–5.5 | 5.6 | 9 | 5.6–6.3 | 5.9 |
| *elongata* | 1 | 7.9 | | | | |
| *indus* | 3 | 5.9–6.2 | 6.1 | 2 | 6.7–6.9 | 6.8 |
| *laevigata* | 4 | 5.3–6.6 | 6.0 | 2 | 6.5–6.8 | 6.7 |
| *laevigatoides* (Philippines) | 3 | 5.5–6.4 | 6.1 | 4 | 5.9–6.9 | 6.4 |
| *laevigatoides* (Java) | 1 | 6.6 | | 4 | 7.5–8.4 | 7.9 |

TABLE 4

*Diplocheila polita* group: Variation in Ratio Clypeus: W/L.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *polita* | 17 | 3.54–4.46 | 4.07 | 11 | 3.48–4.30 | 3.91 |
| *quadricollis* | 1 | 3.12 | | 3 | 3.16–3.72 | 3.41 |
| *distinguenda* | 3 | 3.10–3.38 | 3.24 | 9 | 2.96–3.40 | 3.23 |
| *elongata* | 1 | 3.28 | | | | |
| *indus* | 3 | 5.25–5.75 | 5.58 | 2 | 6.90–7.15 | 7.02 |
| *laevigata* | 4 | 3.50–4.15 | 3.74 | 2 | 3.78–3.95 | 3.86 |
| *laevigatoides* (Philippines) | 3 | 4.92–5.40 | 5.10 | 4 | 5.45–5.70 | 5.41 |
| *laevigatoides* (Java) | 1 | 5.20 | | 4 | 5.00–5.60 | 5.21 |

TABLE 5

*Diplocheila polita* group: Variation in Ratio Labrum: max. L/min. L.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *polita* | 17 | 2.50–3.50 | 2.82 | 11 | 2.50–3.12 | 2.83 |
| *quadricollis* | 1 | 2.10 | | 3 | 2.26–2.34 | 2.30 |
| *distinguenda* | 3 | 2.18–2.26 | 2.22 | 9 | 1.77–2.38 | 2.17 |
| *elongata* | 1 | 1.85 | | | | |
| *indus* | 3 | 3.84–6.00 | 4.78 | 2 | 6.20–7.25 | 6.72 |
| *laevigata* | 4 | 2.00–3.60 | 2.84 | 2 | 2.56–2.88 | 2.72 |
| *laevigatoides* (Philippines) | 3 | 4.80–5.75 | 5.12 | 4 | 4.00–5.40 | 4.70 |
| *laevigatoides* (Java) | 1 | 3.43 | | 4 | 3.00–4.00 | 3.33 |

TABLE 6

*Diplocheila polita* group: Variation in Ratio Labrum: W/min. L.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *polita* | 17 | 5.60– 7.70 | 6.72 | 11 | 5.80– 7.25 | 6.53 |
| *quadricollis* | 1 | 5.50 | | 3 | 6.00– 6.90 | 6.50 |
| *distinguenda* | 3 | 6.00– 6.25 | 6.12 | 9 | 5.20– 7.30 | 6.23 |
| *elongata* | 1 | 5.40 | | | | |
| *indus* | 3 | 8.50–11.80 | 9.60 | 2 | 11.40–14.00 | 12.70 |
| *laevigata* | 4 | 6.00– 7.56 | 6.60 | 2 | 6.20– 6.90 | 6.55 |
| *laevigatoides* (Philippines) | 3 | 10.00–10.20 | 10.10 | 4 | 8.35–10.60 | 9.79 |
| *laevigatoides* (Java) | 1 | 8.20 | | 4 | 6.55– 8.55 | 7.60 |

TABLE 7

*Diplocheila polita* group: Variation in Ratio max. L/Labrum/L ant. seg. 1.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *polita* | 17 | 0.57–0.68 | 0.63 | 11 | 0.61–0.70 | 0.65 |
| *quadricollis* | 1 | 0.55 | | 3 | 0.60–0.61 | 0.605 |
| *distinguenda* | 3 | 0.44–0.46 | | 9 | 0.41–0.50 | 0.46 |
| *elongata* | | | | | | |
| *indus* | 2 | 0.62–0.69 | 0.66 | 2 | 0.78–0.84 | 0.81 |
| *laevigata* | 3 | 0.61–0.71 | 0.67 | 2 | 0.64–0.70 | 0.67 |
| *laevigatoides* (Philippines) | 3 | 0.71–0.80 | 0.75 | 4 | 0.71–0.80 | 0.75 |
| *laevigatoides* (Java) | 1 | 0.66 | | 4 | 0.66–0.72 | 0.69 |

TABLE 8

*Diplocheila polita* group: Variation in Ratio PN: W wp/L.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *polita* | 17 | 1.20–1.34 | 1.28 | 11 | 1.21–1.34 | 1.30 |
| *quadricollis* | 1 | 1.28 | | 3 | 1.30–1.33 | 1.31 |
| *distinguenda* | 3 | 1.23–1.32 | 1.27 | 9 | 1.20–1.31 | 1.26 |
| *elongata* | 1 | 1.23 | | | | |
| *indus* | 3 | 1.29–1.35 | 1.33 | 2 | 1.38–1.42 | 1.40 |
| *laevigata* | 4 | 1.16–1.23 | 1.21 | 2 | 1.20–1.25 | 1.23 |
| *laevigatoides* (Philippines) | 3 | 1.25–1.31 | 1.27 | 3 | 1.26–1.31 | 1.29 |
| *laevigatoides* (Java) | 1 | 1.33 | | 4 | 1.25–1.29 | 1.23 |

TABLE 9

*Diplocheila polita* group: Variation in Ratio PN: L/W Base.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *polita* | 17 | 0.86–0.95 | 0.92 | 11 | 0.84–0.95 | 0.90 |
| *quadricollis* | 1 | 0.85 | | 3 | 0.86–0.89 | 0.87 |
| *distinguenda* | 3 | 0.92–0.97 | 0.95 | 9 | 0.93–0.97 | 0.95 |
| *elongata* | 1 | 0.89 | | | | |
| *indus* | 3 | 0.86–0.91 | 0.88 | 2 | 0.78–0.82 | 0.80 |
| *laevigata* | 4 | 0.95–1.06 | 1.00 | 2 | 0.97–1.00 | 0.98 |
| *laevigatoides* (Philippines) | 3 | 0.89–0.91 | 0.90 | 3 | 0.85–0.92 | 0.89 |
| *laevigatoides* (Java) | 1 | 0.90 | | 4 | 0.88–0.91 | 0.89 |

*Diplocheila polita* group: Specimens *incertae sedis.*

Two female specimens, from the collection of the Museum of Comparative Zoology, taken at Rajmahal, India, seem to possess certain of the diagnostic features of *polita* and certain of the features of *indus.* Both have the *indus*-type stylus, that is with relatively long spines, sinuate inner margin, and dorsal carinae. Both have four setae on the labrum, and both have the labrum and clypeus shallowly emarginate (labrum: max. L/min. L 6.24-6.30, and clypeus: L/W 4.06-4.26), these features being characteristic of *polita.* In addition, the posterior thoracic angles are not prominent as in *indus*, and the general external appearance is more like that of *polita* than *indus.* Thus these specimens form a morphological connecting link between *indus* and *polita.*

The data are not sufficient to permit a sound decision as to the taxonomic significance of these specimens.

Subgenus **Neorembus,** new subgenus

*Diplocheila* Brullé (in part), in Audouin and Brullé, 1834: 407.

Genotype: *Rembus latifrons latifrons* Dejean, 1831 (here designated).

*Submera* Habu (in part), 1956: 58. **New Synonymy.**

This subgenus contains a single ditypic species which may be distinguished from *Diplocheila* (*s. str.*), and subgenus *Isorembus* Jeannel by the following characters.

Head with two supraorbital setigerous punctures over each eye; front flat, except for frontal impressions, not depressed medially; clypeus flat, twice as wide as labrum, anterior margin deeply concave; labrum wider than long, sex-

setose, anterior margin broadly emarginate, base of emargination slightly angulate or broadly rounded, lobes approximately symmetrical, slender, apices acute; mandibles trigonal, elongate, edentate (see description under "Mandibles of *Diplocheila*", above and figs. 4a-e), basal portion of stria 1 present, scutellar stria free, not joined to sutural portion of stria 1; eighth sternite of female as in fig. 50, differing from that of *daldorfi* in that the posterior margin is more oblique, membranous area is smaller, the area anterior to the membranous area is wider, and the lobes are narrower; female retractile stylus as in fig. 64, with two or four spines on outer margin.

The type species of the subgenus, *Diplocheila latifrons*, ranges throughout the Oriental Region, in the Greater Sundas and Philippines, and northward in eastern China at least to the latitude of Shanghai, and in the Japanese Archipelago.

**Diplocheila (Neorembus) latifrons** Dejean

The distinctive features of this species are the same as those given for the subgenus.

Two geographical subspecies of *Diplocheila latifrons* are recognized here and are distributed as follows: typical race throughout the range as outlined above excluding the Philippines, the atypical subspecies, described here as new, is known only from the island of Luzon, in the Philippines.

As surface sculpture is the same for the two subspecies, it is described here.

Microsculpture: head, lines fine, forming weakly transverse to isodiametric meshes; meshes isodiametric on head and pronotum, strongly transverse on ventral surface of head, meshes weakly transverse on rest of ventral surface. Macrosculpture: head, postorbital area smooth, interorbital area with a few shallow lines laterally, frontal area with several oblique lines between frontal impressions, pronotum with very shallow transverse lines medially; dorsal surface generally micro-punctulate, punctures relatively more numerous on pronotum and elytra than on head; head ventrally with shallow, transverse lines, prosternum crossed transversely by shallow lines, laterally with short, longitudinal lines, thoracic episterna and lateral portions of pro- and metasternum with zig-zag lines, abdominal sternites rugulose laterally, with longitudinal lines. Surface generally shining, head more glossy than pronotum and elytra, slightly iridescent, sclerites of ventral surface weakly iridescent.

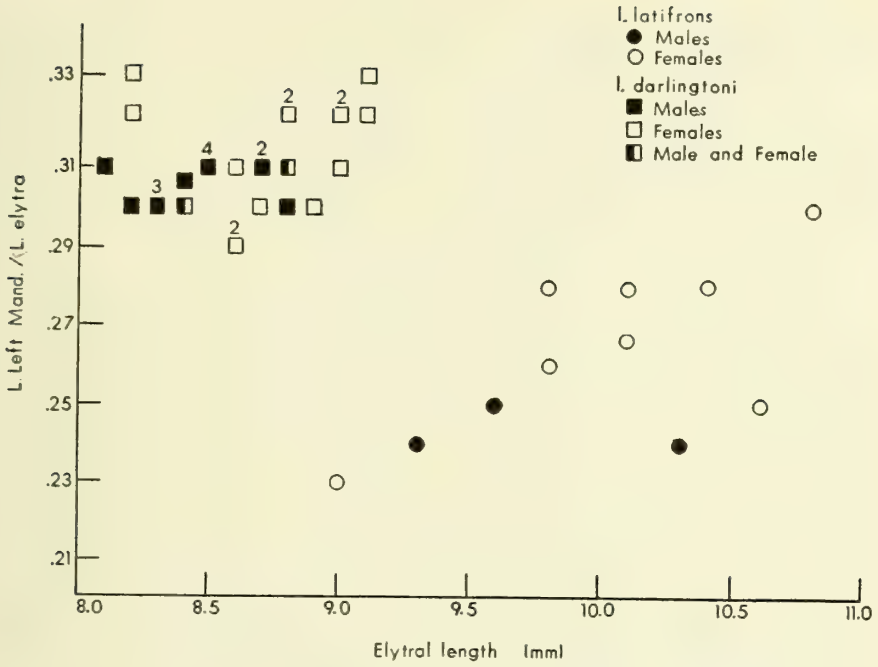
**Diplocheila latifrons latifrons** (Dejean)

*Rembus latifrons* Dejean, 1831: 679. Type locality: Oriental India (determined from original description).—Dejean and Boisduval, 1830: 204, pl. 97, fig. 4.—Laferté, 1851: 279.
*Rhembus latifrons* Bates, 1892: 327.
*Diplochila latifrons* Lesne, 1904: 72.—Andrewes, 1922: 283 and 286.
*Rembus opacus* Chaudoir, 1852: 67. Type locality: Chusan (determined from original description).—Bates, 1873: 265.
*Rhembus opacus* Bates, 1889: 267.
*Diplocheila opaca* Andrewes, 1922: 283 and 286.
*Submera latifrons* Habu, 1956: 61, figs. 5, 14, 18.

This subspecies may be separated from the Luzon sample by the following characteristics: greater average length, proportionately shorter mandibles [2]; pronotum with sides anteriorly and posterior lateral angles more rounded.

*Variation.*—Variation in mensural characters and ratios of diagnostic importance are presented in Tables 11-15 and in Graph 1. Mandibular length seems to vary approximately allometrically as a function of elytral length (or overall size). Frontal impressions vary considerably in shape, extent, and depth. Labral and pronotal variations are indicated in terms of a Calcutta female in table 10. The pronotum varies especially in configuration of the sides, but is always more broadly rounded than in the atypical subspecies. The posterior incurving may be rather abrupt, as in the Calcutta specimen, or more gradual.

[2] For measurements see tables 11-15 and Graph 1.




Graph 1.—The relationship between the ratio length of left mandible/length of elytra and the length of the elytra in *Diplocheila latifrons* Dejean.

The labral ratios are given with similar data for the atypical subspecies in table 15. This variation seems to be correlated with geographical distribution, the specimens from China having a distinctly lower ratio, i.e., shorter labral lobes than the specimens from India, while the Malacca-Java-Indo-China specimens are intermediate in this character, as well as geographically. The Chinese and Indian specimens differ also in pronotal shape; specimens from the intermediate localities being more like those from India. It may be possible to divide this subspecies into two, but I choose not to do it here as I have seen so few specimens. If and when such action is taken, the Chinese, or more northern race, will take the name *D. l. opaca* Chaudoir, 1852.

There is no appreciable variation in the shape of the female stylus in the specimens examined by me.

Median lobe of male genitalia as in fig. 77; specimen collected in Java, Fry coll., 1905:100 (British Mus. N. H.). No appreciable variation was found in the four males examined by me.

*Distribution.*—See Andrewes (1930) for a list of localities in which this species has been taken.

I have seen and dissected four males and nine females from the following localities.

INDIA: Calcutta, Rajmahal. MALACCA: Tengah Geb. JAVA: "Java", Modojopang. INDO-CHINA: Hanoi, Tonkin. CHINA: Shanghai, Mokansan, Chi-Kiang.

**Diplocheila latifrons darlingtoni,**[3] new subspecies

The diagnostic features of this subspecies are presented above in conjunction with the distinguishing features of *D. latifrons latifrons.* The two forms overlap broadly with respect to overall size, in length of the mandibles, elytral length, and in the ratio length of left mandible/elytral length (see tables 11-15), although there are average differences between the two in these characters. However, when the above ratio is considered in conjunction with elytral length (a measure of overall size, but more easily and rapidly measured) the two subspecies are clearly separated from one another (see graph 1). I choose not to regard them as different species because of their general similarity in all other structural characters, excluding the slight differences in configuration of the lateral margins of the pronotum.

An individual specimen of *latifrons* may be determined to subspecies by plotting its mandibular-elytral ratio against elytral length in graph 1 and observing where the point determined falls with respect to the two groups of specimens included here.

*Description.*—Type, female, Central Plain of Luzon, P. [hilippine] I. [slands], Feb.-Sept., 1945, (Darlington), [Museum of Comparative Zoology Coll.].

Female. Length 13.8 mm., width 6.0 mm. General proportions as in the typical subspecies but seemingly more slender. Color and sculpture as in typical subspecies.

Head with frontal impressions punctiform and moderately deep, extending posteriorly to plane of anterior pair of supraorbital setigerous punctures, front between impressions with a small concavity, which extends also on to posterior margin of clypeus. Clypeus strongly transverse, 8.60 times wider than long, 2.30 times wider than labrum, slightly concave in vertical plane, anterior margin broadly emarginate, exposing basal margin of labrum. Labrum sexsetose broadly and deeply emarginate, base of emargination broadly rounded, not angulate, 1.81 times wider than long, width 6.15 times greater than minimum length, maxi-

[3] This subspecies is named after its collector, Dr. P. J. Darlington, Jr., who loaned me this fine series of specimens and gave me permission to describe it.

mum length 3.26 times greater than minimum length; lobes narrowing strongly but evenly from base to apex, apex of each lobe narrowly rounded. Mandibles as described for typical subspecies but more elongate.

Pronotum as in fig. 33 with anterior margin moderately concave, sides moderately arcuate and reflexed more broadly so anteriorly than posteriorly causing sides to appear strongly constricted posteriorly, anterior angles rounded, posterior angles narrowly rounded; dorsal surface as in typical subspecies; apex of metepimeron broadly rounded.

Elytra with striae moderately deeply impressed, as in typical subspecies.

Female stylus as in typical subspecies.

*Allotype*.—Same data as for type.

Male. Differs from the female in no essential features. Length 13.0 mm., width 5.6 mm. Head 2.24 times wider than long, frontal impressions somewhat shallower and more elongate than in type. Clypeus 10.0 times wider than long, 2.18 times wider than labrum. Labrum 1.84 times wider than long, width 5.75 times greater than minimum length.

Pronotum with posterior angles slightly more rounded than in type.

Abdominal sternites laterally somewhat more rugose than in type.

Median lobe as in typical subspecies.

*Variation*.—Data on variation in the following mensural characters and ratios are presented in tables 11-15—total length, length of elytra, length of left mandible, L left mand./L elytra, labrum: max. L/min. L. Usually the frontal impressions are as described for the allotype, but there is some variation in shape and depth, the average condition resembling that described for the allotype. The pronotum is as described for the type, with exceptions: two males with sides more broadly rounded medially, three females with sides more constricted posteriorly. Sculpture varies slightly.

The female retractile stylus does not exhibit any appreciable variation in shape. Setae on the outer margin vary in number from two to four (usually two), inner margin with a single seta. The median lobe of the male genitalia does not exhibit any noticeable variation.

In addition to the type and allotype, sixteen males and fourteen females, paratypes, have been dissected and examined, all with the same locality data as the type. Sixteen paratypes are retained in my collection. The type and the remaining paratypes have been returned to the Museum of Comparative Zoology.

TABLE 10

SUMMARY OF LABRAL AND PRONOTAL VARIATION IN *D. l. latifrons*.

| Locality | Labrum: Notes | Labrum: max. L/min. L | Pronotum |
|---|---|---|---|
| Calcutta | as in fig. 20b | 4.00 | |
| Rajmahal | as in fig. 20b | 3.44 | slightly more strongly constricted than in fig. 32 |
| Malacca | lobes shorter and broader basally | 2.70 | as in fig. 32 |
| Java | like Malacca spec., but lobes still shorter | 2.40<br>2.40<br>2.44<br>2.76 | as in fig. 32 |
| Indo-China | lobes short, as in Malacca spec., but emarg. shallower | 2.60<br>2.46 | more incurved post. than in fig. 32 |
| China | lobes short and broad basally, emarg. broadly angular at base | 2.34<br>2.22<br>2.00 | more convex, more strongly const. ant., less rounded lat., hind angles less obtuse than in fig. 32 |

TABLE 11

*Diplocheila latifrons*: VARIATION IN TOTAL LENGTH (MM.).

| Subspecies | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| *latifrons* ..... | 3 | 13.9–14.3 | 14.1 | | |
| *darlingtoni* ..... | 17 | 12.5–13.3 | 12.9 ± 0.06 | 0.24 ± 0.04 | 2.0 |
| | | Females | | | |
| *latifrons* ..... | 9 | 13.5–16.0 | 15.0 | | |
| *darlingtoni* ..... | 15 | 12.5–13.9 | 13.3 ± 0.13 | 0.49 ± 0.09 | 3.7 |

TABLE 12

*Diplocheila latifrons*: VARIATION IN LENGTH OF LEFT MANDIBLE (MM.).

| Subspecies | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| *latifrons* ..... | 3 | 2.2–2.5 | 2.4 | | |
| *darlingtoni* ..... | 17 | 2.5–2.7 | 2.6 ± 0.01 | 0.07 ± 0.01 | 3.0 |
| | | Females | | | |
| *latifrons* ..... | 9 | 2.1–3.2 | 2.7 | | |
| *darlingtoni* ..... | 15 | 2.5–3.0 | 2.8 ± 0.03 | 0.14 ± 0.02 | 5.0 |

TABLE 13

*Diplocheila latifrons:* Variation in Length of Elytra (mm.).

| Subspecies | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | | Males | | |
| *latifrons* ..... | 3 | 9.3–10.3 | 9.7 | | |
| *darlingtoni* ..... | 17 | 8.1– 8.8 | 8.5 ± 0.05 | 0.20 ± 0.03 | 2.0 |
| | | | Females | | |
| *latifrons* ..... | 9 | 9.0–10.6 | 10.1 | | |
| *darlingtoni* ..... | 15 | 8.2– 9.2 | 8.8 ± 0.08 | 0.31 ± 0.06 | 3.5 |

TABLE 14

*Diplocheila latifrons:* Variation in Ratio L left Mand/L El.

| Subspecies | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | | Males | | |
| *latifrons* ..... | 3 | 0.24–0.25 | 0.24 | | |
| *darlingtoni* ..... | 17 | 0.29–0.31 | 0.30 ± 0.002 | 0.01 ± 0.001 | 3.3 |
| | | | Females | | |
| *latifrons* ..... | 9 | 0.23–0.30 | 0.27 | | |
| *darlingtoni* ..... | 15 | 0.30–0.33 | 0.32 ± 0.003 | 0.01 ± 0.002 | 3.0 |

TABLE 15

*Diplocheila latifrons:* Variation in Ratio Labrum: max. L/min. L.

| Subspecies | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | | Males | | |
| *latifrons* ..... | 3 | 2.00–2.76 | 2.38 | | |
| *darlingtoni* ..... | 17 | 2.56–3.30 | 2.88 ± 0.04 | 0.18 ± 0.03 | 6.3 |
| | | | Females | | |
| *latifrons* ..... | 9 | 2.20–4.00 | 2.74 | | |
| *darlingtoni* ..... | 15 | 2.76–3.58 | 3.03 ± 0.06 | 0.22 ± 0.04 | 5.9 |

## Species *incertae sedis*

*Diplocheila minima* Jedlička, 1931: 103, [type specimen a male, in the collection of Dr. Breuning at Wien, (fide. Jedlička)]. Type locality: Szetschuan Province, Kiating, China (determined from original description).

It is impossible to tell from the original description whether or not this species belongs to the genus *Diplocheila.* Until this problem is settled *minima* must stand where it is placed here.

Subgenus **Isorembus** Jeannel

*Diplocheila* Brullé (in part), Audouin and Brullé, 1834: 407.

*Isorembus* Jeannel, 1949: 771. Habu: 1956: 52.

GENOTYPE: *Rembus aegyptiacus* Dejean, 1831; (designated by Jeannel, in reference cited above).

*Submera* Habu (in part), 1956: 58. **New Synonymy.**

GENOTYPE: *Diplocheila zeelandica* Redt. (designated by Habu in the reference cited above).

*Shirahataia* Habu, 1956: 63. **New Synonymy.**

GENOTYPE: *Submera macromandibularis* Habu and Tanaka, in Habu, 1956: 63; (designated by Habu in the reference cited above).

The distinguishing characteristics of this subgenus are presented in the key. The range of *Isorembus* is: Antillean subregion of the Neotropical; Nearctic; eastern and southern edges of the Palaearctic, as far north as Korea in the east, and southern Spain in the west; Oriental, including the Greater Sundas and the Philippines; Ethiopian, including Madagascan subregion.

*Key to the Species of Subgenus Isorembus*

1. Head with 1 supraorbital setigerous puncture over each eye, left mandible with a premolar thickening between terebral margin and retinacular ridge (figs. 7 and 8) ..... *aegypticaca* group 3

   Head with two supraorbital setigerous punctures over each eye, left mandible without a premolar thickening between terebral margin and retinacular ridge ..... 2

2. Basal portion of stria 1 present, scutellar stria free, apex of prosternum not margined between front coxae ..... *zeelandica* group 5

   Basal portion of stria 1 absent, scutellar stria joined to sutural portion of stria 1, apex of prosternum margined between front coxae *striatopunctata* group [4]

3. Thickening at base of terebra of left mandible 2/3 the length of terebra .. 4

   Thickening at base of terebra of left mandible about ½ the length of terebra (fig. 8) ..... *D. aegyptiaca* Dej.

4. Dorsal surface of mandibles strigose, pronotum cordate (fig. 7) *D. cordicollis* Laf.

   Dorsal surface of mandibles smooth, pronotum almost quadrate *D. transcaspica* Sem.

5. Claw-bearing segment of tarsus with a row of setae on each ventro-lateral margin, segments 1-4 with two rows of setae on each lateral margin; 6th abdominal sternite with four setae in the males, six setae in the females ..... 6

[4] Key to species of this group is at the beginning of the section dealing with it.

Claw-bearing segment of tarsus without a row of setae on each ventro-lateral margin ..... 7

6. Elytral striae punctate ..... *D. pinodes* Andr.
Elytral striae impunctate ..... *D. zeelandica* Redt.

7. Right mandible with outer margin strongly curved, slightly sinuate before apex, apical portion very broad; elytral striae normally impressed, 6th abdominal segment with four setae in the males, five or six setae in the females ..... *D. macromandibularis* Habu & Tanaka.
Right mandible with outer margin moderately curved, not sinuate before apex, apex more acute; elytral striae shallowly impressed; tarsal segments 1-4 with a single row of setae on each lateral margin; 6th abdominal segment with two setae in the males, four setae in the females *D. laevis* Lesne.

## *zeelandica* group

In addition to the characters presented in the key, the members of this group may be differentiated from members of the other two groups by the shape of the 8th sternite (see fig. 51), and the shape and proportions of the female stylus. The basal bulb of the median lobe of the male genitalia is not broadly emarginate dorsally.

The group ranges throughout the Oriental Region, Greater Sundas, Philippines, Japan, Formosa, the Chinese mainland.

**Diplocheila (Isorembus) zeelandica** (Redtenbacher)

*Rembus zeelandicus* Redtenbacher, 1867: 10, t. 1, fig. 5. Type locality: Auckland, New Zealand; (determined from original description).
*Rhembus zeelandicus* von Heyden, 1879: 330.—Andrewes, 1923 (1924): 464.
*Submera zeelandica* Habu, 1956: 58, figs. 7, 13, 19, 23, 28.
*Rhembus gigas* Bates, 1873: 256.—Andrewes, 1923 (1924): 464.—Putzys, 1875: 49.

The diagnostic features of this species are indicated in the key. In non-genitalic characters *D. zeelandica* is most like *pinodes*. The shape of the female stylus is distinctive except for one specimen from Japan with a stylus like that of *D. laevis*.

*Description of sculpture.*—(female, Kweiling, Kwangsi, China) Museum of Comparative Zoology Coll. Microsculpture forming isodiametric meshes on dorsal surface of head and pronotum, weakly transverse meshes on ventral surface, the latter very weakly iridescent, head and pronotum micropunctate, pronotum and elytra microgranulate. Macrosculpture: head, post-orbital area with fine, transverse anastomosing lines, interorbital area laterally with a few deeper, longitudinal lines, front with a single transverse line, frontal impressions with

numerous fine lines, pronotum with shallow but distinct transverse lines, anterior margin medially with short longitudinal lines, prosternum with transverse lines, medially, area between lines rugulose, proepisternum with short longitudinal lines, areas between microgranulate, not rugulose, pterosterna medially smooth, laterally with anastomosing zig-zag lines; mes- and metepisterna with anastomosing zig-zag lines; surface of elytral intervals 8 and 9 rugulose, abdominal sternites with irregular longitudinal lines laterally, medially with very shallow transverse lines, 6th sternite micropunctate.

*Variation.*—Size varies as follows: 9 males, length 20.9-24.1 mm. (mean 21.9 mm.), width 9.0-10.1 mm. (mean 9.6 mm.); 4 females, length 20.3-21.4 mm. (mean 21.0 mm.), width 8.8-9.7 mm. (mean 9.4 mm.). The sculpture pattern is the same as described above, lines of macrosculpture on the pronotum being much finer in two specimens from Kyoto, Japan, and much deeper in one specimen from Nanking, China.

The pronotum (see fig. 34) varies in shape from more cordate than is usual (male, Pei Bey) to less so, with the sides less sinuate posteriorly (male, Peking). The metepimeron is obliquely truncate apicolaterally, not sinuate or broadly rounded. Surface lustre is silky in Chinese specimens, more glossy in specimens from Kyoto, Japan, but not nearly so glossy as in *laevis* Lesne. The number of setigerous punctures on the 6th abdominal sternite varies as follows: males, four setae in eight specimens, three setae in one specimen; females, seven setae in one specimen; six setae in three specimens.

A female from Fu-Chau, Fukien Province has the blade of the retractile stylus broader than in fig. 65, emargination near apex more pronounced; a female from Pei Bey—as in fig. 65 but blade somewhat broader; specimen from Kyoto, Japan, differs from fig. 65 in that the blade is shorter, broader, with apex obliquely truncate. The median lobe of the male is as in fig. 78.

*Synonymical Notes.*—The synonymy presented above was suggested by Bates (1873) when he described *R. gigas*, and was verified by Andrewes (1924). Probably the type locality of *zeelandica* as given by Redtenbacher is erroneous, as neither this species nor any other species of *Diplocheila* has ever been taken in New Zealand or Australia, and the likelihood of its occurring there is slight. I propose eastern China as a new type locality, as the type specimen probably came from

there. A type locality has not been designated for *Diplocheila gigas* Bates. I suggest that Nagasaki, Japan be regarded as type locality as this was the first locality listed by Bates for the specimens on which the name was based.

*Distribution.*—This species ranges from Korea southward to Kwangsi Province, China, on the mainland, and is found in southern Japan and Formosa.

Nine males and four females have been examined in this study, collected in the following localities.

JAPAN: Kyoto and vicinity, October, 1945. CHINA: Kwangsi Province—Kweiling, April; Wuchow, April; Szechuan Province—Pei Bey, June; Peking, Nanking, spring; Fukien Province—Fuchau. FORMOSA.

**Diplocheila (Isorembus) pinodes** Andrewes

*Diplocheila pinodes* Andrewes, 1922: 281 and 282. Type locality: Annam (Hue) (determined from original description).

The distinctive features of *pinodes* are indicated in the key. The shape of the female stylus clearly separates this species from the other members of the *zeelandica* group (fig. 66; cf. figs. 65 and 67).

*Description.*—Cotype, female, Annam (Hue), February, 1917 (R. V. de Salvaza), [Museum of Comparative Zoology Coll.].

Female. Length 26.1 mm., width 12.8 mm. Surface opaque, not smooth and shining. Microsculpture not studied. Macrosculpture as in *zeelandica.*

Frontal impressions of head broad, shallow, longitudinal basins extending posteriorly to plane of anterior pair of supraorbital setigerous punctures. Clypeus 6.70 times wider than long, 2.04 times wider than labrum, with a deep longitudinally directed groove on each side, anterior margin broadly and deeply emarginate (fig. 21a). Labrum 1.74 times wider than long, width 2.94 times greater than minimum length, maximum length 1.70 times greater than minimum length, anterior margin moderately and somewhat asymmetrically incised, right lobe a little longer and narrower than left lobe (fig. 21b). Right mandible as in *zeelandica,* left not studied.

Pronotum with anterior margin shallowly concave, sides strongly arcuate, constricted more anteriorly than posteriorly, not sinuate posteriorly; disc very broadly and slightly convex medially, becoming more abruptly declivous laterally, flattened postero-laterally, impressions average for genus; metepimeron broadly rounded posteriorly, posterior margin not sinuate laterally. Elytra with striae punctate, moderately deeply impressed, intervals moderately convex. Retractile stylus as in fig. 66. Eighth sternite as in *zeelandica.*

*Distribution.*—This species is known only from Indo-China.

**Diplocheila (Isorembus) macromandibularis** Habu and Tanaka

*Submera macromandibularis* Habu & Tanaka, 1956: 63, figs. 3, 4, 6, 17, 25, 26. [Type specimen a male; in the possession of Akinobu Habu?] Type locality: Tobi Shima, Yamagata Prefecture; Japan (stated by Habu to be the locality in which the holotype was collected).

As I have not seen a representative of *macromandibularis*, the following remarks are based on a study of Habu's illustrations and very fine description of this species. Most of the external diagnostic features of this species are indicated in the key. An additional feature concerns the condition of the apical carina of the elytron (the continuation of the eighth interval apically). As Habu (1956: 67) points out, in *zeelandica* this carina is isolated from the rest of the eighth interval, whereas in *macromandibularis* the carina contacts the more basal portion of the eighth interval. Further, as Habu (1956: 67) writes, the two setigerous punctures closest to the apex of the elytron are located before the apices of the third and fourth intervals in *zeelandica*, whereas in *macromandibularis* they are located before the apices of the second and third intervals.

The claw-bearing tarsal segments of *macromandibularis* are glabrous and in this respect this species resembles *laevis*. In the number of setae on the sixth abdominal sternite, *macromandibularis* resembles *zeelandica* and *pinodes*. The female stylus (female palp) of *macromandibularis* is similar in shape to, but shorter and broader than, the stylus of *zeelandica*. The shape of the apex of the median lobe is similar in *macromandibularis* and in *laevis*. The shape of the right mandible is the most distinctive feature of this species and possibly one could remove this species from the *zeelandica* group on the basis of this character. However, I do not consider it advisable to take this action.

**Diplocheila (Isorembus) laevis** Lesne

*Rhembus laevis* Lesne, 1896: 243, fig. 6.—Bouchard, 1903: 171.
*Diplocheila laevis* Lesne, 1904: 72, t. 8, fig. 8, text—fig. 6.—Andrewes, 1922: 284 and 286.

The highly polished integument and shallow elytral striae are diagnostic characteristics of this species. The female stylus of *laevis* is similar in shape to that of a Japanese specimen of *zeelandica*.

*Variation.*—Size of four males varies as follows: length, 20.8-24.3 mm. (mean 22.9 mm.), width 9.0-10.0 mm. (mean 9.6 mm.). The

microsculpture is isodiametric to weakly transverse on the head and pronotum, isodiametric on the elytra, meshes longitudinal on the proepisternum, transverse on the remaining ventral surface. Macrosculpture is as described for *zeelandica*, but lines are finer and less numerous, the dorsal surface of the head, pronotum, and elytra, and ventral surface of the 6th abdominal sternite is micropunctate, the punctures on the head more numerous than in *zeelandica*. The Leyte specimens have the lines of macrosculpture somewhat deeper than in a specimen from Tonkin, especially on the head and pronotum. One Leyte specimen has the surface of the left elytron crenulate and opaque, but the right elytron is normal for the species. The clypeus and labrum are as in *pinodes* (figs. 21a and b). The pronotum is as in fig. 35. The metepimeron is the same as in *zeelandica*. The elytra are more parallel-sided than in *zeelandica*. Median lobe of the male genitalia is as in fig. 79; female stylus as in fig. 67 (one male and one female dissected).

*Distribution.*—This species ranges throughout southeast Asia, the Greater Sundas, and the Philippines. Andrewes (1930) gives a list of localities.

I have seen four males and one female from the following localities.

INDO-CHINA: Tonkin. PHILIPPINE ISLANDS: Plains of N.E. Leyte, Nov. 1944-Jan. 1945 (Darlington).

### *aegyptiaca* group

Diagnostic characters of this group, in addition to those presented in the key are: claw-bearing tarsal segments each with a row of setae on each ventro-lateral margin; segments 1-4 with a single row of setae on each ventro-lateral margin; elytra with basal portion of stria 1 absent, scutellar stria joined to sutural portion of stria 1; 8th sternite as in fig. 58; retractile stylus as in fig. 52; median lobe of male as in fig. 81c.

The pattern of macrosculpture is essentially the same as described for *zeelandica* (see above); dorsal surface of elytra microgranulate; dorsal surface of head, pronotum and elytra micropunctulate.

*Aegyptiaca* and *transcaspica* are similar to one another and differ from *cordicollis* in lacking grooves on the dorsal surface of the mandibles, in pronotal shape, and in having a more glossy integument. *Transcaspica* and *cordicollis* are closer to one another in the length of the premolariform area of the left mandible, and in the retention of the terebral margin. Thus *transcaspica* seems to occupy an intermediate

position between *cordicollis* and *aegyptiaca* morphologically as well as geographically.

The range of the group is the Ethiopian Region, Madagascan Subregion, southern edge of the Palaearctic (southern Spain, Persia and Transcaspian provinces of the U.S.S.R.) and peninsular and northern India.

**Diplocheila (Isorembus) cordicollis** Laferté

*Rembus cordicollis* Laferté, 1851: 279. Type locality: "India" (determined from original description).
*Diplocheila cordicollis* Andrewes, 1930: 149.

The diagnosic features of this species are in the key.

*Description.*—Male. India, 77.15.K. (British Museum Nat. Hist.). Length 17.2 mm., width 6.6 mm. Surface subopaque, with a dull lustre. Sculpture not studied, dorsal surface micropunctulate.

Front of head broadly depressed anteriorly, depression extending posteriorly to equatorial plane of eyes, frontal impressions broad, shallow basins. Clypeus and labrum as in *D. aegyptiaca* (see figs. 22a and b). Mandibles as described in section dealing with structure of mandibles of *Diplocheila*. Pronotum as in fig. 36, disc flat medially, impressions average for genus; metepimeron with apex subtruncate medially, becoming sinuate laterally. Elytra with striae moderately deeply impressed, intervals slightly convex. Median lobe of male genitalia as in fig. 80a.

*Distribution.*—This species ranges in India from Bombay northeastward to Delhi, and eastward to Bengal. Andrewes (1930) gives locality records.

**Diplocheila (Isorembus) transcaspica** Semenov

*Rhembus transcaspicus* Semenov, 1890: 278.—Reitter, 1900: 151.
*Diplocheila transcaspica* Andrewes, 1919: 100.—*Ibid.*, 1930: 152.

The diagnostic features of this species are indicated in the key.

*Description.*—Male. N.A. and S.K. Zool. Surv. Ind., Labi Baring, Seistan, 7.XII.18, under drift, at edge of Hamun. Sta. 19, B.S. (British Museum Nat. Hist.)

Length 12.2 mm., width 5.1 mm. Integument black, shining. Sculpture normal for genus, elytra finely microgranulate, dorsal surface of head, pronotum and elytra micropunctate.

Frontal impressions very shallow and broad posteriorly, indicated anteriorly on each side by a small, shallow depression. Clypeus 6.45 times wider than long, 2.32 times wider than labrum, anterior margin deeply emarginate. Labrum with anterior margin broadly and slightly asymmetrically emarginate,

base of emargination rounded rather than angulate, lobes as in *cordicollis.* Mandibles as in *cordicollis,* but dorsal surface smooth, not strigose. Pronotum subcordate, with anterior margin shallowly and broadly concave, sides moderately arcuate anteriorly, incurving posteriorly, becoming slightly sinuate in basal 1/3, disc flattened medially, becoming rather sharply declivous antero-laterally, flattened baso-laterally, impressions average for genus; metepimeron rounded apically, tapering gradually laterad, not deeply constricted nor sinuate. Elytra with intervals slightly convex, striae not deeply impressed, distinctly punctate, interval 3 with a single puncture in apical 1/3.

Male genitalia not studied.

*Type locality.*—Two localities are mentioned by Semenov (1890) in his original description of *transcaspica,* Tedschen, Trans-Caspian Province, and Dort-Kuju. Which of these two will be the type locality cannot be determined until the label on the type specimen is examined.

*Distribution.*—The range of this species extends from Persia through the transcaspian province of Russia, to extreme western Afghanistan. Semenov (1926) states that this species is widespread in the Persian desert and the adjacent parts of India.

**Diplocheila (Isorembus) aegyptiaca** Dejean

*Rembus aegyptiacus* Dejean, 1831:680; (type specimen in the Berlin Museum (fide Bedel)). Type locality: (determined from original description), Alexandria, Egypt.
Fairm., 1886:18.—Harold, 1879:22.—Bedel, 1895-1914:102.—Reitter, 1900:151.

*Rembus aegyptius* Klug, 1832: t. 24, f. 11.—Bedel, 1895-1914:102.

*Rembus senegalensis* Dejean, 1831:681. Type locality: Senegal (determined from original description).—Harold, 1879:22.

*Rembus capensis* Laferté, 1851:278. Type locality: "du Cap" (determined from original description).—Peringuey, 1896:537; (type specimen in the South African Museum (fide Jeannel)). Type locality: Capetown, South Africa (determined from original description).—Jeannel, 1949:772.

*Diplochila capensis* Alluaud, 1930:83.

The diagnostic features of this species are presented in the key.

*Description.*—Female. N.W. Rhodesia, Mwengwa, (W. C. Dollman), B.M. 1919-79. (det. P. de Basilewsky), [British Museum Nat. Hist.] Length 14.6 mm., width 6.1 mm. Surface shining, sculpture as described for *aegyptiaca* group, head as densely micropunctate as pronotum.

Front of head sloping, impressions broad, shallow basins. Clypeus about five times wider than long, 2.00 times wider than labrum, anterior margin deeply emarginate (fig. 22a). Labrum 1.40 times wider than long, width 2.22

times greater than minimum length, broadly, angularly, and asymmetrically incised, apical angles narrowly rounded, right lobe slightly longer and narrower than left lobe, quadrisetose (fig. 22b). Mandibles as described in section dealing with mandibles of *Diplocheila*, molariform area 0.33 times in length the distance from base of terebra to apex. Pronotum as in fig. 37, disc flattened medially, declivous laterally, more strongly so anteriorly. Elytra with striae moderately deeply impressed, shallowly punctate, intervals slightly convex, interval 3 with puncture in apical 1/3 ±. 8th sternite and retractile stylus as in figs. 52 and 68.

Male. Cape Good Hope (Africa), from Muche (Staudinger and Bang-Haas, '52), [Museum of Comparative Zoology Coll.]. Similar to the female in essentials, differing in detail. Length 12.8 mm., width 5.5 mm.

Frontal impressions of head very shallow and broad. Mandibles as in female. Pronotum with hind angles slightly more rounded than in female, lateral margins slightly sinuate a short distance before hind angles. Metepimeron broadly rounded posteriorly. Elytra with striae quite shallow and punctate, intervals very slightly convex, interval 3 with a single puncture in apical 1/3. Median lobe more strongly distended than in *cordicollis* (fig. 81).

*Variation.*—A second male from the Cape of Good Hope differs in no essentials from the male described above. The outstanding difference between the two males and the female is the more extensive molariform area of the left mandible of the female.

*Synonymical Notes.*—The type specimen of *D. senegalensis* appears to be a small, teneral specimen of *aegyptiaca.* The Cape of Good Hope population has been named twice, each time with the same name, but by different authors. *D. capensis* Peringuey was treated as a synonym of *aegyptiaca*, but was removed from synonymy and treated as a species distinct from the latter by Jeannel (1949). This worker claims that *capensis* can be distinguished from *aegyptiaca* by the following combination of characters: sides of the pronotum not sinuate posteriorly, posterior angles obtuse and very rounded, and pronotal disc smooth, without transverse rugosities. This species, according to Jeannel, ranges from the Cape of Good Hope to southern Spain, and eastward to Madagascar, whereas *aegyptiaca* is known only from Egypt. He does not mention *senegalensis.* The two specimens which I have seen from the Cape Region may be characterized as follows: sides of the pronotum slightly sinuate posteriorly, posterior angles of the pronotum slightly rounded (a little more so in the female described above), and the disc finely rugose. These specimens can be referred to *D. aegyptiaca* on the basis of the diagnostic features presented by Jeannel.

Laferté (1851) also described a *Rembus capensis* from the Cape which he considered to be closely related to *aegyptiaca*, and which could be distinguished from the latter by the absence of punctures in the elytral striae and by its slightly narrower pronotum. I assume that this specimen was drawn from the same population as was Peringuey's type specimen. The two specimens from the Cape Region examined by me both have the striae so finely punctate that the punctures could easily be overlooked. I am unable to comment on the narrower pronotum, having seen no specimen of *aegyptiaca* from anywhere near the type locality of this species. Thus on the basis of one out of two of Laferté's supposedly diagnostic characteristics the specimens before me could be identified as *aegyptiaca.*

The data presented above indicate that *Diplocheila aegyptiaca* is represented in the Cape Region and that *capensis* is a synonym of it.

Possibly the Madagascan population of *capensis* represents a distinct species or subspecies which may be separated from the mainland populations by the characters presented by Jeannel, for in addition to the pronotal characters, the median lobe of the male genitalia as indicated in fig. 368 (Jeannel: 1949) differs somewhat in shape from the single *aegyptiaca* median lobe which I have examined.

*Distribution.*—Known from southern Spain and from several localities through Africa as far south as the Cape of Good Hope and including the island of Madagascar, *D. aegyptiaca* has one of the most extensive distributions of any species of carabid (Alluaud: 1930). Bedel (1895-1914), and Jeannel (1949) record this species from a number of localities.

### *striatopunctata* group

All members of this group have the claw-bearing tarsal segment without a row of setae on each ventro-lateral margin; segments 1-4 with a single row of setae on each ventro-lateral margin; 8th sternite of female with the membranous area elongate and narrow (fig. 53); female stylus moderate in size, apex broadly rounded, without spines; median lobe of male with basal bulb not broadly emarginate dorsally.

The sculpture and lustre of the integument is constant throughout the *striatopunctata* group and is described here.

Integument more or less glossy, head always more so than pronotum and elytra. Microsculpture: head, lines very fine, forming weakly transverse meshes dorsally, strongly transverse ventrally, pronotum with meshes isodiametric, weakly transverse on ventral and lateral sclerites of thorax, and abdominal sternites, the ventral and lateral sclerites weakly iridescent. Surface of head dorsally with fine widely spaced micropunctures, surface of pronotum and elytra densely micropunctate. Macrosculpture: head dorsally with obsolescent lines in postorbital and interorbital areas; pronotum medially with obsolescent transversely directed lines, and a few short longitudinally directed lines along posterior and anterior margins medially; pro and metasternum with transverse shallow lines, laterally with a few shallow anastomosing lines, lateral thoracic sclerites with shallow, anastomosing lines, these areas slightly rugulose; abdominal sternites smooth medially, with shallow, longitudinal lines laterally; genal lines on head weakly indicated posteriorly or completely absent. The most distinctive feature of the sculpture is that the head is almost lacking in macrosculpture lines, and has very few micropunctures as compared with the pronotum and elytra. The lateral thoracic sclerites are smoother than average for the genus.

A useful character in distinguishing some of the species in this group is the number of spines in certain rows on the hind tibia. There is a maximum of five longitudinal rows of spines on each hind and middle tibia. If the hind tibia is viewed from a posterior aspect, one longitudinal groove can be seen on each side, each groove bearing a row of spines. The row closest to the body is referred to as the posterior internal row, that on the outside, or away from the body, as the posterior external row. Anterior to each of these rows is a row of finer spines, the anterior internal and external respectively. On the posterior convex surface, between the posterior internal and external rows, there may be an additional row of spines which is referred to as the posterior median row. This row exhibits the most variation in number of spines.

*Key to the Species of the striatopunctata group*

1. Elytra concolorous ..... 2
   Elytra with even intervals reddish brown, odd intervals black
   *D. striatopunctata* LeC.
2. Posterior angles of the pronotum not sharply angulate ..... 3
   Posterior angles of the pronotum sharply angulate ..... 4
3. Elytral intervals flat, not transversely crenulate. Size: females, length 9.1-12.3 mm., width, 3.7-5.3 mm.; males, length 9.1-11.8 mm., width 3.6-5.1 mm. ..... *D. obtusa* Lec.
   Elytral intervals convex, the striae deeply impressed, intervals transversely crenulate. Size: females, length 11.1-14.5 mm., width 5.0-6.8 mm.; males, length 13.1 mm., width 5.3 mm. ..... *D. undulata* Carr.
4. Elytral stria 6 distinctly impressed throughout its length, as deep as or slightly less so than 1-5, or if distinctly less, then size is larger than indicated in the following alternative ..... 5
   At least elytral striae 6 and 7 completely absent, or barely discernible. Size: females, length 9.1-13.0 mm., width 3.8-5.6 mm.; males, length 8.6-12.6 mm., width 3.6-5.8 mm. ..... *D. nupera* Csy.
5. Left mandible without a median dorsal tubercle, dorsal surface in lateral aspect flat, not elevated (fig. 9) ..... 6
   Left mandible with a low median dorsal tubercle, at least some elytral intervals noticeably convex (usually 6 and 7); dorsal surface in lateral aspect elevated (fig. 6c); elytral striae deeply impressed; eyes prominent, strongly convex; interval 3 either with or without a single puncture; total number of spines in the posterior median rows of both hind tibiae 2-10. Size: females, length 13.0-18.6 mm., width 5.8-8.6 mm.; males, length 11.5-17.3 mm., width 4.9-7.7 mm.
   *D. striatopunctata* LeC.
6. Size: females, length 15.8-22.0 mm., width 7.0-9.6 mm.; males length 15.2-19.4 mm., width 6.6-8.6 mm. ..... 10
   Size: females, length 16.8 mm. or less, width 5.0-7.6 mm.; males, length 9.9-16.0 mm., width 4.2-7.0 mm.[5] ..... 7
7. Elytral interval 3 with a single puncture, intervals flat, the striae shallowly to moderately deeply impressed; eyes prominent, strongly convex, number of spines in posterior median row of hind tibiae 0-3 ± .... 8
   Elytral interval 3 impunctate, intervals flat, the striae shallowly impressed; eyes not prominent, not strongly convex; number of spines in the posterior median row of hind tibiae 4-10 ± ..... *D. oregona* Hatch.
8. Lateral margins of the pronotum broadly rounded, anteriorly strongly incurved toward anterior angles, anterior margin *appearing* narrower than posterior margin ..... 9
   Lateral margins of pronotum anteriorly less strongly incurved toward anterior angles, lateral margins less broadly rounded; anterior margin not appearing narrower than posterior margin ..... *D. modesta* Csy.

[5] Specimens which fall in the overlap zone of these measurements are either *D. major,* or *D. assimilis.* To determine, check descriptions.

9. Anterior margin of pronotum moderately concave, lateral margins anteriorly more strongly constricted (fig. 41), stria 6 generally as distinct as 1-5, and more deeply impressed than 7 .. *D. a. assimilis* LeC.
   Anterior margin of pronotum more deeply concave, sides more broadly rounded anteriorly, stria 6 usually considerably finer and more shallowly impressed than 1-5, and usually only slightly or not at all more distinct than stria 7 ..... *D. a. planulata* Csy.
10. Pronotum more or less quadrate, lateral margins anteriorly not strongly curving inward toward anterior angles; anterior margin only moderately deeply concave (fig. 44); number of spines in posterior median row of hind tibiae 0-8 (mean 4) ..... *D. m. major LeC.*
    Lateral margins of pronotum anteriorly curving strongly inward toward anterior angles, anterior margin *appearing* narrower than posterior margin (fig. 45); number of spines in both posterior median rows of hind tibiae 0-2 (usually 0) ..... *D. m. melissisa* n. subsp.

The range of this group as a whole is the Nearctic Region, probably from near tree-line in the north to southern Texas and Cuba in the Antillean subregion of the Neotropical Region.

**Diplocheila (Isorembus) striatopunctata** LeConte

*Rembus striatopunctatus* Le Conte, 1844: 50 [type specimen a male, in the Le Conte Coll., MCZ no. 2729, Museum of Comparative Zoology, Harvard University]. Type locality: Carlisle, Pa. (determined from original description).—*Ibid.,* 1848: 419.

*Diplocheila striatopunctata* Casey, 1920: 200, 202, 203.

*Rembus impressicollis* Le Conte (not Dejean), 1848: 419.

*Diplochila impressicollis* Horn (not Dejean), 1880: 52.

*Diplochila alternans* Casey, 1897: 347; [type specimen a male, in Casey Coll., USNM no. 47375, United States National Museum]. Type locality: Bayfield, Wisconsin (determined from original description).—*Ibid.,* 1913: 149.

*Diplocheila alternans* Casey, 1920: 200, 202.

*Diplocheila amplipennis* Casey, 1920: 202; **New synonymy;** [type specimen a female in Casey Coll., USNM no. 47380]. Type locality: "Lake Superior" (determined from original description).

*Diplocheila brevicollis* Casey, 1920: 203; **New synonymy;** [type specimen a female in the Casey Coll., USNM no. 47381]. Type locality: Ogdensburg, New York (determined from original description).

*Rembus brevicollis* Notman, in Leonard, 1926: 229.

The pronotum of this and the following species differ from those of the other North American *Diplocheila* except *D. modesta* Csy. in being slightly sinuate and more strongly incurved posteriorly, the hind angles of the pronotum are angulate and elytral stria 7 is always deeply impressed. A combination of larger size, more convex and prominent eyes, slightly to moderately convex intervals, and punctate striae distinguish this species from *oregona* Hatch. The presence or absence of a single puncture in elytral interval 3 is too variable a character in *striatopunctata* to be of use in distinguishing this species from *oregona.*

*Variation.*—Data on variation in length, width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. Lustre of the integument is generally rather silky, but is glossy in some specimens. Two color phases occur in this species. In one the integument of the dorsum is all black, as is normal for the genus. In the other, the bicolored phase, elytral intervals 2, 4, 6, and 8 are reddish-brown while the rest of the integument of the dorsum is black. No intergrades between these two phases are known. The frequency of occurrence of the two phases is not the same in every area; the bicolored phase seems to be absent in the Pacific Northwest, less frequent than the concolorous phase in the northeast, and more frequent than the concolorous form in the midwest. Ball (1954: 173-174) discusses this in some detail.

Frontal impressions vary in length, depth, and distinctness, but with no geographical regularity. The pronotum generally is as in fig. 38, but varies to slightly more constricted posteriorly. This is especially noticeable in some specimens from Washington and Oregon. However, this variation characterizes individuals, not population samples. The elytral intervals vary slightly in convexity, and are pock-marked in a few individuals. The striae are invariably punctate although the size of the punctures varies slightly. The puncture of interval 3 may be present on both elytra, on one elytron, or absent from both. See Ball (1954: 175) for details. No variation was observed in the median lobe of the male (fig. 82), or in the female retractile stylus (fig. 69) (3 males and 3 females dissected).

*Synonymical Notes.*—The name long used for this species, *impressicollis* Dejean, 1831 is based on a specimen that Lindroth (1955: 17)

says is conspecific with *laticollis* Le Conte (= *assimilis* Le Conte). The correct name for this species is thus *striatopunctata.*

The specimen labelled as the type of *striatopunctatus* in the Le Conte collection has bicolored elytra. Le Conte did not mention this fact in his original description and I therefore doubt that the specimen labelled as such is the type. An additional eight specimens labelled *impressus* in the Le Conte Collection are examples of *striatopunctata,* except " *impressus* 5 ", which is *oregona* Hatch.

The most distinctive form included here as a synonym of *striatopunctata* is *alternans* Casey, referred to as the " bicolored phase " in the discussion of variation. The bicolored individuals seem to average slightly larger in size than the concolorous ones but otherwise the two are very similar. The color difference could be due to the effect of a pair of alleles of a single gene and the size difference is not enough to be of taxonomic importance. If the two forms were allopatric there would be some basis for giving the bicolored phase a name, but the two occur together over much of the total range of the species and, at least at McLean Bogs, Tompkins County, New York, in the same habitat.

*D. amplipennis* Casey is supposed to differ from *striatopunctata* (= *impressicollis auct.*) by being " longer, much broader, and with finer and virtually impunctate striae, the labrum has much more unequal lobes than in that [*striatopunctata*] species." These differences are variable. No two specimens have the lobes of the labrum of exactly the same proportions, and size is variable. The striae are finely punctate, but the fineness of punctation is just one stage in a graded series. In all other features the type of *amplipennis* is typical *striatopunctata.*

*D. brevicollis* is based on a single specimen collected at Ogdensburg, New York. In length, 14.3 mm., the specimen falls within the range of variation of *striatopunctata.* The anterior tarsi are slightly narrower than the anterior tarsi of Casey's example of *striatopunctata* but the difference is minute. Other supposed differences are narrower form, shorter prothorax, shorter mandibles, more prominent eyes, and more finely punctured striae, but these differences are slight and represent individual rather than population variation.

*Distribution.—Diplocheila striatopunctata* is widespread in North America, ranging northward well into the Northern Coniferous Forest (but probably only along waterways), westward to California, east-

ward to eastern New Jersey, and southward to "Georgia" and "Texas". I have collected representatives of *striatopunctata* in New York State along the margin of a stream, and under logs in low, wet woods on the Ontario Coastal Plain. In addition, I obtained one specimen under a rock, close to the margin of a stream at McMurray, Alberta.

138 males and 148 females collected in the following states and (peripheral) localities have been examined.

Peripheral localities—QUEBEC: Montreal. NEW JERSEY: Hudson County, Arlington. "GEORGIA". "TEXAS". CALIFORNIA: "Yolo County". NORTHWEST TERRITORIES: Fort Smith. Additional states and provinces—ALBERTA. ILLINOIS. INDIANA. IOWA. KANSAS. MANITOBA. MICHIGAN. MINNESOTA. MONTANA. NEBRASKA. NEW YORK. NORTH DAKOTA. OHIO. ONTARIO. OREGON. PENNSYLVANIA. SASKATCHEWAN. SOUTH DAKOTA. UTAH. WASHINGTON. WISCONSIN.

**Diplocheila (Isorembus) oregona** Hatch.

*Rembus oregonus* Hatch, 1951: 119; [type specimen a male, in coll. of Melville H. Hatch, U. of Washington; allotype and one other paratype in Hatch coll.; 5 paratypes in coll. K. and D. M. Fender.]. Type locality: McMinneville, Oregon (determined from original description).

In addition to the diagnostic characters mentioned in the key and in connection with the diagnosis of the preceding species, *oregona* differs from all other species of the *striatopunctata* group in having the microgranulation of the elytra coarser, and the micropunctures of the pronotum so small as to be readily overlooked at a magnification of 54 diameters. The elytra seem to lack micropunctation.

*Variation.*—Data on variation in length, width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. There is slight variation in convexity of the eyes, and of the elytral intervals. The elytral striae of the Utah specimens are slightly shallower than average, and are impunctate. In all of the other specimens examined the striae are finely punctate. In 21 specimens the basal portion of stria 1 is indicated very feebly, sometimes as a broken line, but not joined to the sutural portion of 1. In two specimens from Medicine Hat, one from the Cypress Hills, and one from Jenner, Alberta, the basal portion of stria 1 is joined to the sutural portion, and the sutural stria is free. However, the basal portion of 1 is weakly

developed in the latter group of specimens. In the remaining specimens there is no indication of the basal portion of stria 1, and the scutellar and sutural portions of 1 are joined.

The genitalia and retractile plates were not examined.

*Synonymical Notes.*—Charles Schaeffer used three different label names for this species: *Rembus brevicornis*, *carri*, and *parvus* but failed to publish any of these. These specimens, bearing holotype labels, are in the collection of the United States National Museum. In the Le Conte Collection, *Rembus impressus* no. 5 collected in Oregon, is a member of this species. This name was not published by Le Conte.

*Distribution.*—The range of this species is the northern portion of the Plains, from Winnipeg, Manitoba northward to Edmonton, Alberta, southward into "Utah" and "Nevada", and westward across the mountains to western Oregon.

Twenty-two males and fifteen females, collected in the following localities, have been examined.

ALBERTA: Cypress Hills, Edmonton, Jenner, Medicine Hat, Redwater, Tothill. MANITOBA: Winnipeg. "NEVADA". SASKATCHEWAN: Regina. "UTAH".

**Diplocheila (Isorembus) modesta** Casey

*Diplocheila modesta* Casey, 1920: 203, [type specimen a female, USNM no. 47379, and one paratype male, USNM no. 47379, in Casey Coll.]

*Diplocheila modesta* exhibits a combination of certain diagnostic features of both *assimilis* and *striatopunctata*, and for this reason it cannot be readily distinguished from either. The characters on which this species may be separated from *assimilis* are: smaller body, stria 7 usually deeper, pronotum with sides posteriorly incurved and sinuate and appearing narrower. From *D. striatopunctata*, *modesta* may be separated more readily, as it lacks a protuberance on the dorsal surface of the left mandible, has fewer spines in the posterior median row of the hind tibiae (0-2), the integument is glossy, the elytral intervals are either flat or very slightly convex, and the body is smaller.

*Description.*—Type, female. Montreal, Canada, 23.VII.98. A moderately convex beetle with glossy integument, resembling *striatopunctata* in pronotal shape, and *assimilis* in other features. Length 12.3 mm., width 5.8 mm. Frontal impressions broad and shallow. Clypeus, labrum, and mandibles about as described for *striatopunctata.* Pronotum with sides arcuate, more abruptly constricted anteriorly than in *assimilis,* becoming slightly convergent and slightly sinuate basally; convexity and impressions average for *striatopunctata* group. Elytra with striae 1-5 sharply impressed, weakly punctate toward base, impunctate apically; stria 6 slightly shallower than 1-5, 7 slightly shallower than 6, but distinctly impressed and easily visible; interval 3 of both elytra with a single puncture in apical 1/3 ±. Retractile stylus not examined.

*Variation.*—Data on variation in length, width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. Frontal impressions of the head vary from small, distinctly rounded pits to slightly larger, shallower, and less clearly defined impressions. The sides of the pronotum posteriorly vary from moderately incurved and slightly sinuate to more strongly incurved and more noticeably sinuate. The sides anteriorly appear to be more abruptly incurved in all specimens than in *assimilis.* Elytral stria 7 varies from faint to as strongly impressed as striae 1-6. Stria 6 is always present and distinctly impressed. The striae are generally sharply impressed but in a few specimens they are very shallow. Punctation of the striae varies from complete on 1-6 to impunctate, generally intermediate between these extremes. The intervals are generally flat, but are weakly convex in a few specimens. Retractile styli and male genitalia as in *striatopunctata* (3 males and 3 females dissected).

*Discussion.*—The recognition of *modesta* as a distinct species is more a matter of expediency than conviction because the majority of diagnostic features which distinguish this form from its congeners *striatopunctata* and *assimilis* seem to be nothing more than a partial combination of the diagnostic features of the latter two, in a group of individuals of smaller average size.

The majority of diagnostic or partially diagnostic features of *modesta* seem to ally this species more closely with *assimilis* than with *striatopunctata.*

Size alone is not sufficient to distinguish all of the individuals of the two species, but two groups with well separated means are present (tables 16 and 17). Pronotal shape is the only single reliable feature in distinguishing between *modesta* and *assimilis* and the difference between the two types of pronota is not very pronounced.

*Modesta* and *assimilis* or *modesta* and *striatopunctata* are not subspecies because wherever *modesta* has been found the other two species have been taken in the same locality or nearby. For example, thirty-eight specimens representing these three species were collected at Britannia, Ontario, on the same day and within a relatively small and ecologically homogeneous area. Further, I have collected *modesta* and *striatopunctata* in the same wood in Wayne County, New York, on the same day.

It is possible that *modesta* is a hybrid between *assimilis* and *striatopunctata*, and its geographical distribution is consistent with this.

*Distribution.*—This species is largely northeastern in distribution, ranging from Wisconsin and Iowa eastward to at least western Quebec and New Jersey. I have collected a single specimen in New York State, under logs in low wet woods on the Ontario coastal plain.

In addition to the type I have seen twenty-five males and forty-three females collected in the following peripheral localities.

Ontario: Britannia. Massachusetts: Suffolk County, Cambridge. Maryland: Harford County, Edgewood. Iowa: Dickinson County, Lake Okoboji. Additional States—Connecticut. Illinois. Michigan. New Jersey. New York. Ohio. Pennsylvania. Wisconsin.

**Diplocheila (Isorembus) assimilis** Le Conte

The more or less trapezoidal form of the pronotum separates this species from all other *Diplocheila* excepting *major* and *nupera* (fig. 41). Its smaller size and punctate elytral striae distinguish *assimilis* from *major melissisa*, and *assimilis* is larger and has the elytral striae more clearly indicated than has *nupera*.

*Diplocheila assimilis* is ditypic, with the typical subspecies widely distributed in southeastern Canada and United States east of the Rocky Mountains, ranging southward to southeastern Texas, and being replaced in the southern one-third of Texas by *D. a. planulata*, which extends southward at least to Brownsville.

*Diplocheila assimilis assimilis* Le Conte.

*Rembus impressicollis*[6] Dejean, 1831:682; [type specimen in Oberthur Coll., (fide Lindroth)]. Type locality: "Amer. septentrionale" (determined from original description).

*Rembus assimilis* Le Conte, 1844:51; [type specimen a male, in the Le Conte Coll., MCZ no. 5703]. Type locality: "Georgia" (determined from original description).—Ibid., 1848:418.

*Diplochila assimilis* Horn, 1880:52.

*Rembus laticollis* Le Conte, 1848:418 [type specimen a female, in the Le Conte Coll., MCZ no. 5702]. Type locality: Syracuse, New York (determined from original description).

*Diplochila laticollis* Horn, 1880:52.—Casey, 1897:347.

*Diplocheila laticollis* Casey, 1920:200-204.

*Diplochila cliens* Casey, 1897:347 and 348; [type specimen a female, Casey Coll., USNM no. 47376]. Type locality: Kansas (determined from original description).—Ibid., 1913:148.

*Diplocheila foveata* Casey, 1920:201; **New synonymy**; [type specimen a female, in Casey Coll., USNM no. 47378]. Type locality: Lake Champlain, New York (determined from original description).

*Rembus foveata* Notman, in Leonard, 1926:229.

This subspecies has the anterior margin of the pronotum moderately deeply concave, the sides anteriorly more strongly constricted, stria 6 generally as distinct as striae 1-5 and more deeply impressed than 7, whereas the atypical subspecies generally has the anterior margin of the pronotum more deeply concave, the sides more broadly rounded anteriorly, stria 6 usually considerably finer and more shallowly impressed than 1-5, and usually slightly or not at all more distinct than stria 7 which in extreme examples is completely absent.

The features used to distinguish these subspecies are variable and largely relative, and are quantitative in nature but cannot be expressed numerically. However, specimens of *assimilis* from southern Texas are slightly but noticeably different from specimens which occur farther to the north; at least 75% of the two forms are distinguishable from one another and each has a mutually exclusive geographical range. Thus the minimum requirements for recognition of subspecies are fulfilled.

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[6] See "Synonymical Notes" for discussion of application of the name *Diplocheila impressicollis* Dejean.

*Description.*—Type, male. Georgia [Museum of Comparative Zoology Coll.].

Male. Length 11.0 mm., width 4.6 mm. Lustre glossy. Sculpture as described for *striatopunctata* group. Frontal impressions of head round foveae. Eyes of average convexity. Pronotum with sides slightly and evenly incurved basally, more strongly incurved anteriorly; linear pit in bottom of posterio-lateral impressions short (as in *foveata* Csy). Elytra with striae moderately deeply impressed, distinctly punctate throughout, 6 weaker than 1-5, 7 medially as distinct as 6, obsolete basally and apically (excluding deepened portion in apical 1/5), intervals slightly convex. Male genitalia not dissected.

Female (type of *Diplocheila laticollis* LeC.). Syracuse, New York. Length 13.0 mm., width 6.0 mm. Lustre and sculpture as above. Frontal impressions of head small, moderately deep pits. Clypeus, labrum, and mandibles as described for *striatopunctata.*

Pronotum 1.48 times wider than long, 1.50 times wider at base than at apex with sides incurving gradually anteriorly, more strongly constricted anteriorly than posteriorly; posterior-lateral impressions broad and shallow, linear pits at bottom longer than in type of *assimilis.* Elytra with striae shallowly impressed, 7 very feebly indicated, 6 visible but weak, all impunctate; interval 3 of left elytron with two punctures, interval 3 of right elytron with a single puncture. Retractile stylus not dissected.

*Variation.*—Data on variation in length, width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. The frontal impressions exhibit slight variation in shape and depth, about as is described for *D. major.* The pronotum is more or less trapezoidal in shape, wider than the head, with essentially the same proportions as is exhibited by the type. The sides vary from very slightly to not at all sinuate posteriorly, and anteriorly they constrict rather strongly from the widest point to the anterior angles. The pronotum varies in appearance from transverse to almost quadrate. The anterior margins may be either moderately or strongly concave, and the anterior angles vary from broadly to narrowly rounded. The depth and extent of the posterio-lateral linear pits vary from relatively deep and short to relatively shallow and long.

Elytral striae 1-5 are always about equally deep; 6 is either as deep as 1-5 or somewhat shallower, and 7 varies from indistinct to about as deep as 6. About 90 percent of the specimens examined have the elytral striae punctate, but the punctures vary in size and distinctness from very fine to moderate, and easy to see at a magnification of 9 diameters. The remaining 10 percent of the specimens examined have the striae

completely impunctate. This variation is not geographical. Interval 3 of each elytron bears a single puncture. The male genitalia and female retractile plates are the same as for *D. striatopunctata* (3 males and 3 females dissected and studied).

*Synonymical Notes.*—This species has commonly been referred to as *Diplocheila*, or *Rembus laticollis*, for the past seventy-four years. Horn (1880) gave *assimilis* as a synonym of *laticollis*, although the former had four years priority.

According to Lindroth (1955: 17) the type specimen of *Diplocheila impressicollis* Dejean, 1831, is conspecific with the type specimen of *Diplocheila laticollis* Le Conte, 1848 (= *assimilis* Le Conte, 1844). Therefore, *impressicollis* is the correct name for this species, and *assimilis* and *laticollis* are its junior synonyms. However, Lindroth (1955: 32) expressed the view that the name *impressicollis* should be suppressed at least until the correct name of the species *impressicollis auctorum* (= *striatopunctata* Le Conte, 1844) becomes established by usage. I accept this opinion and follow it here.

Horn's synonymy is correct from a zoological standpoint. The types of *assimilis* and *laticollis* differ in size, *laticollis*, a female, being larger and *assimilis*, a male, approaching the lower limit of the size range for its species. The two differ slightly in relative proportions and in punctation of the elytral striae. The latter is the chief diagnostic character to separate them but it is a very variable feature, only a relatively few specimens of those examined having the striae completely impunctate. The remaining specimens with punctate elytra show every gradation from having distinct punctures on all of the striae from base almost to apex, to a very few fine punctures concentrated in the basal portion of striae 1-4.

The Casey named forms *D. cliens* and *D. planulata* are treated as varieties of *laticollis* [= *assimilis*] in Leng, 1920: 62. I consider *D. planulata* to be a weakly defined geographical subspecies and will discuss it below. *D. cliens* is regarded here as a synonym of *assimilis assimilis*.

The type of *cliens* was characterized by Casey as follows: pronotum 3/5 wider than long, apex barely 3/4 as wide as base. My measurements of the type specimen yield these ratios: W PN/L-1.54; W PN base/W apex-1.46. A comparison of these figures with the same ratios

for the type of *laticollis* shows that the width-length relationship is close for the two and that the apex is slightly wider in *cliens* than in *laticollis*. A series of nine *assimilis* females from McLean Bogs, New York (about 40 miles from Syracuse, the type locality of *laticollis*) shows a range of variation in the latter ratio from 1.45-1.62, which brackets the value of this ratio for *cliens*. Neither of these two ratios is useful for separating *cliens* from *laticollis* as a different species. The elytra of *cliens* are said to be 2/5 wider than the prothorax. My measurements give these ratios: W El/W PN for *cliens*—1.30; for *laticollis* —1.29. This ratio is apparently of no diagnostic significance, the difference being very slight. The elytra are more arcuate in the type specimen of *cliens* than in the type specimen of *laticollis* but this difference is bridged through the series of specimens in question and their punctation is very similar, in fact almost identical. However, the specimens which Casey had labelled as *laticollis* (a female from Riverside, Ill., a female from Ottawa, Ont., and a male from eastern Ont.) have elytral striae 6 and 7 and the elytral punctation more pronounced than in the type specimen of *cliens*.

Another individual variant described by Casey was named *D. foveata*. The type specimen is a female collected at Lake Champlain, New York. The distinctive features of this specimen lie in the very short and deep posterio-lateral foveae of the pronotum, in the relatively broad appearance of the body, and in stria 7 being " deep, but more broadly impressed than the others ". The length of this specimen is 13.8 mm., width 6.3 mm. Both of these measurements fall within 1 S.D. from the mean for the series of *assimilis*. The foveae of the pronotum are relatively short and deep but this is a variable feature, and in a series of specimens of *assimilis* varies independently of the other diagnostic features of *foveata*. The variability of elytral stria 7 is too great to be used as a diagnostic specific character, although its complete absence is of some value in distinguishing *planulata*.

The named forms treated above as synonyms cannot be treated as subspecies because they all occur within the range of typical *assimilis*.

*Distribution.*—I have not seen any specimens of this species from the southeast other than the type specimens of *assimilis*. Fattig (1949: 30) records this species from several localities in the state of Georgia: Atlanta, Cartersville, Douglasville. Löding (1945: 11) states

that this species occurs " over state " of Alabama.

In addition to the type, eighty-two males and ninety-six females, collected in the following states, have been examined.

Peripheral localities—Quebec: Montreal. Massachusetts: Suffolk County; Wellesley. Texas: Dallas. New Mexico: Bernalillo County; Albuquerque. Minnesota: Ramsey County; Saint Paul. Additional states and provinces—District of Columbia. Illinois. Indiana. Iowa. Kansas. Maryland. Michigan. New Jersey. New York. Ohio. Oklahoma. Ontario. Pennsylvania. Rhode Island. South Dakota. Wisconsin.

**Diplocheila assimilis planulata** Casey

*Diplochila laticollis* Casey (not LeC.), 1897: 347.

*Diplochila planulata* Casey, 1913: 149; [type specimen a male, in Casey Coll., USNM no. 47377]. Type locality: Austin, Texas; (determined from original description).

The diagnostic features of this subspecies are indicated in the key and in the discussion of the distinguishing characteristics of *D. a. assimilis.*

*Description.*—Type, male. " Texas " [United States National Museum Coll.].

Male. Length 13.5 mm., width 6.3 mm. Sculpture and lustre as in the typical subspecies. Frontal impressions of head broad. Eyes of average convexity. Pronotum with sides constricted anteriorly, widest behind middle, anterior margin deeply concave (fig. 42). Elytra with striae 1-4 normally impressed, 5 somewhat finer than average, 6 and 7 very faint almost lacking, 1-5 finely punctate. Interval 3 of each elytron with a single puncture, intervals 1-4 slightly convex, the remaining flat. Male genitalia not dissected.

*Variation.*—Data on variation in length, width, and the number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. The frontal impressions are shallower on the average than in the typical subspecies, elongate, and in some specimens broad and poorly defined. The eyes vary from moderately to strongly convex, as in the typical subspecies.

The sides of the pronotum are either more broadly rounded than in the typical subspecies or as broadly rounded. The anterior margin of the pronotum is more deeply concave than in the typical subspecies in all specimens examined. The posterior lateral impressions vary from very short to normal length, about the same range of variation occurring in the typical subspecies. Elytral striae 1-5 are about equally

deep but 5 in some specimens is slightly finer than 1-4. Stria 6 is finer than 5 except in two specimens from Brownsville where it is just as well defined as 5. Stria 7 varies from completely absent to finely and weakly indicated. The punctation of striae 1-5 varies from finely, but distinctly, punctate throughout to finely punctate basally, impunctate apically. Striae 6 and 7 are impunctate.

One male and one female were dissected and the male genitalia and female stylus were like those of *striatopunctata.*

*Distribution.*—This subspecies is known from Austin, Kingsville, and Brownsville, in southeastern Texas.

Two specimens were taken by me, at light, in Austin, Texas.

Three males and eleven females, collected in the following localities, have been examined.

TEXAS: "Texas". Cameron County, Brownsville. Kleburg County, Kingsville. Travis County, Austin.

**Diplocheila (Isorembus) nupera** Casey

*Diplochila nupera* Casey, 1897: 347; [type specimen a female, in the Casey Coll., USNM no. 47382]. Type locality: Lake Worth, Florida; (determined from original description).—Ibid., 1913: 149.

*Rembus angusticollis* Blatchley, 1928: 61; [type specimen a female, in Blatchley Coll., Purdue University]. Type locality: Dunedin, Pinellas County, Florida; (determined from original description).

The smallest specimens known in the genus are members of this species, and *D. nupera* probably occupies the smallest geographical area of any known species of *Diplocheila.* Its diagnostic features are indicated in the key.

*Diplocheila nupera* was described as a distinct species and is treated as such here. On the basis of size it is as different from *assimilis* as that species is from *major,* and the latter are, in all probability, specifically distinct. Therefore, in spite of the fact that *nupera* and *assimilis* seem to replace one another geographically and are closely related, I consider them to be specifically distinct.

*Description.*—Type, female Fla. Length 10.2 mm., width 4.4 mm. Sculpture average for genus, luster glossy, as in *assimilis.* Frontal impressions of head shallow and broad. Clypeus, labrum and mandibles average for the *striatopunctata* group. Eyes of average convexity. Pronotum with anterior angles less rounded than in *assimilis,* anterior margin broadly and moderately concave, sides arcuate, slightly sinuate posteriorly, more strongly incurved anteriorly,

as in *assimilis* LeC. (see fig. 43). Elytra with striae 1-4 punctate, obsolete basally and apically, stria 5 feebly indicated, 6 and 7 completely lacking. Retractile stylus not examined.

*Variation.*—Data on variation in length, width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. The pronotum is quite variable in form. A specimen from Fort Myers strongly resembles *assimilis* in pronotal shape but the anterior margin is more deeply concave, and the posterior lateral impressions are not as broad as in *assimilis*. A specimen from Biscayne Bay, Florida has the lateral margins strongly sinuate, which gives the pronotum a rather elongate and narrow apearance (PN: W/L-1.50). The remaining specimens are close to the type in pronotal shape. In the series of specimens examined striae 1 and 2 are about as deep as the discal striae in *assimilis*. Striae 3 and 4 are the same as striae 1 and 2 except in a single specimen from Biscayne Bay: stria 3 is finer than 1 and 2, and 4 is barely discernible. In this same specimen 5 is barely discernible, and 6 and 7 are completely absent. Stria 5 varies from as distinct as 1 and 2 to very faint, the extreme seen only in the Biscayne Bay specimen (5 barely discernible) and in a specimen taken at Paradise Key (5 as deep as 1 and 2). Striae 6 and 7 are barely discernible in all specimens examined, except the individual collected at Biscayne Bay in which these striae are completely absent.

*Synonymical Notes.*—The specimen upon which the name *Rembus angusticollis* is based differs from typical *nupera* only in the pronotum. The sides are much less abruptly constricted anteriorly, and the disc is slightly more declivous anteriorly. As the shape of the pronotum is quite variable in *nupera*, I do not think that the type of *angusticollis* represents a distinct species.

The type of *angusticollis* is 9.4 mm. long, 4.0 mm. wide and there is one spine in the posterior median row of each hind tibia. The retractile stylus was not studied.

*Distribution.*—This species is known to occur in the southern half of peninsular Florida, ranging from Dunedin, Pinellas County, to Royal Palm Park, Dade County.

In addition to the types, I have studied three males and eight females collected in the following localities.

FLORIDA: Dade County—Ardi Cr.; Biscayne Bay; Homestead; Miami; Paradise Key; Royal Palm Park. Lee County—Fort Myers.

**Diplocheila (Isorembus) major** Le Conte

The distinguishing characteristics of this species are indicated in the key.

This named form has been variously treated by different authors. Le Conte (1853) decided that this species was not, after all, distinct from *laticollis* (= assimilis LeC.), and synonymized the two names. Horn (1880) followed Le Conte. Wickham (1896) treated *major* as a variety of *laticollis*. Casey (1913) regarded *major* as being specifically distinct from *laticollis* and authors since that time have followed his lead.

The main diagnostic feature used to separate *assimilis* and *major* has been size, length in particular. The total length of all available specimens belonging to *assimilis* or *major* was determined. These data were analyzed by Dr. William T. M. Forbes who concluded that they represented two curves which overlapped one another about 5.0%, which is the area between two and three standard deviations from the mean of each curve. (Forbes, 1954 for description of method of analysis). When the pattern of geographical variation was perceived it became possible to determine to species the specimens which were in the overlap zone in the original analysis because each size group exhibited geographical variation in different features, or in a different manner for the same features (see characterizations of the subspecies of *major* and *assimilis*). The coefficient of difference between each pair of samples was calculated (see Mayr *et al.*, 1953: Chap. 7) and the results are presented in table 16. A coefficient of difference of 1.75 between two samples indicates a joint overlap of 4%, and values higher than this indicate an even slighter overlap. Thus the amount of overlap exhibited by the samples with values higher than this figure are probably slight. I conclude that the two size groups are specifically distinct.

*Diplocheila major* may be divided into two geographical subspecies. The typical one ranges from Massachusetts westward to southeastern South Dakota, and southward, probably east of the 100th Meridian, to northeastern Texas. Its exact southern limits are unknown to me as no records are available from southern New Jersey to the gulf coastal area. Possibly a blend zone between the typical and atypical subspecies occurs in the Coastal Plain area of North Carolina south-

ward to the gulf strip and peninsular Florida. The southern subspecies is known from Cuba, Florida, and on the gulf strip westward to at least Dallas, Texas, and probably farther south in southeastern Texas.

**Diplocheila major major** Le Conte

*Rembus major* Le Conte, 1848:418; [type specimen a female, in the Le Conte coll., MCZ no. 5704]. Type locality: "*ad urbes Detroit et Nov. Aurelianum*"; (determined from original description).—Ibid., 1853:388.

*Diplochila major* Horn, 1880:52. Wickham, 1896:43.—Casey, 1913:148.

*Diplochila expansa* Casey, ibid.; [type specimen a female, in the Casey Coll., USNM no. 47372]. Type locality: Keokuk, Iowa; (determined from original description).

*Rembus expansa* Leng, 1918:62.

*Diplochila oblonga* Casey, 1913:48; [type specimen a male, in the Casey Coll., USNM no. 47374]. Type locality: "Kansas"; (determined from original description).

*Rembus oblonga* Leng, 1918:63.

*Diplocheila procera* Casey, 1920:200; [type specimen a female in Casey Coll., USNM no. 47373]. Type locality: "Lake Superior"; (determined from original description).

The shallower emargination of the anterior margin of the pronotum, the marked rotundity of the sides in front of the widest point, and the presence of punctures in the deeper striae of the elytra distinguish this subspecies from the following one. In addition, there are mean differences between the two in the number of spines in the posterior median row of the hind tibiae (table 19).

*Description.*—Type, female. Labelled with a yellow disc (western states).

Length 18.3 mm., width 8.3 mm. Surface with a glossy luster. Sculpture as described for *striatopunctata* group.

Frontal impressions at head linear, moderately deep, extending back a short distance beyond anterior margin of eyes. Eyes of average convexity.

Pronotum with anterior margin rather shallowly concave, slightly arcuate, not appearing strongly constricted in front of widest point, but rotund, slightlty constricted posteriorly; impressions of dorsal surface shallow, posterior lateral impressions broad and shallow, linear pit at inner margin of impression short (fig. 44).

Elytra with striae 1-5 punctate, moderately deep and distinct, 6 shallower, 7 faintly indicated; intervals moderately convex, right elytron with one puncture in interval 3, left with two punctures.

Retractile stylus not studied.

*Variation.*—Data on variation in length, width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. Frontal impressions of the head vary in extent and depth. The pronotum is more or less trapezoidal in shape. The sides are somewhat arcuate, generally rotund anteriorly, little constricted basally, the sides sinuate posteriorly in some individuals. The surface impressions are about the same as in the type.

The elytral intervals vary from broadly and strongly convex to weakly convex. Striae 1-5 are in most individuals the same as in the type, however, in a few, 5 is less pronounced than 1-4. Striae 6 is always finer than 1-4 and 7 varies from weakly developed to absent.

Retractile stylus of the female and genitalia of the male as in *striatopunctata* (3 males and 3 females dissected).

*Type Locality.*—Although two localities are given by Le Conte in his description of *Diplocheila major*, Detroit and New Orleans, the locality from which the type came is not clear. The specimen labelled as type in the Le Conte Collection is not a member of the Gulf Coast population and the original description does not fit Gulf Coastal specimens of this species. As the only " New Orleans " in the United States is on the Gulf Coast, it seems reasonable to assume that this is not the type locality, thus leaving " Detroit " for consideration. The type specimen of *major* is labelled with a yellow disc signifying that this specimen was collected in the " western states ". The only " Detroit " occurring in Le Conte's " western states ", of which I am aware, is in northeastern Texas. My opinion is that Detroit, Texas is the type locality of *D. m. major.*

*Synonymical Notes.*—Three synonyms of this subspecies were described by Casey who applied the name *major* Le Conte to a Louisiana specimen in his collection, and thus to the Gulf Coast population. *Diplocheila oblonga* and *procera* were differentiated from and described in terms of *D. expansa.* Therefore, I will first give reasons for regarding *major major* Le Conte and *expansa* Casey as conspecific, and then discuss the other two named forms in terms of the type specimen of *expansa.*

The pronotum of the type specimen of *expansa* is about the same in shape as that of the type of *major*, and the two specimens are of about the same size (*expansa* is .9 mm. longer and .5 mm. wider than *major*). The principal difference is that elytral stria 7 is completely lacking in

*expansa*, whereas in *major* it is weakly indicated. However, this character is variable.

*D. oblonga* was based on a series of three males, all of which fall within the range of size variation for *D. major:* total length—16.7-19.9 mm.; maximum width: 8.2-8.4 mm. Elytral stria 7 is faintly indicated and 6 is somewhat weaker than usual. However, the relative distinctness of stria 7 is too variable to be of much value taxonomically within the species *major*. The general body form is described as being narrower than in *expansa*. If this is true *oblonga* should have higher values for the ratio total length/maximum width. The range of variation for this ratio in the type series of *expansa* is 2.16-2.17, and in the type series of *oblonga* it is 1.97-2.28. The type specimen of *oblonga*, with a ratio of 2.28, is actually narrower than the type specimen of *expansa* with a ratio of 2.17. However, the two paratypes of *oblonga* are proportionately broader than the type and paratype of *expansa*. The pronotum is somewhat more strongly sinuate posteriorly in *oblonga* than in *expansa*, but this feature also varies sufficiently as to be characteristic of individuals rather than population samples. Elytral punctation varies in the type series from fine to coarse, the expected range in the northern subspecies of *major*. The type specimens of *oblonga* and *expansa* can be distinguished from one another but the gaps between them are bridged by the characters of other individuals, so the two are conspecific.

*D. procera* Casey was described from a single female (length 18.4 mm., width 8.4 mm.). This form differs from *expansa* by the form of the frontal impressions, a character which is highly variable in *Diplocheila major*. The body form is supposed to be much narrower, but the value for the ratio total L/max. W is 2.19 for *procera* and 2.16 for *expansa*. This slight difference does not seem worthy of taxonomic recognition. The pronotum is supposed to be less transverse (*expansa* PN: W/L 1.57, *procera* PN: W/L 1.42, type of *major* LeC. PN: W/L 1.58) but the calculated range of variation of *major* includes all three of these values (Ball 1954: 222-223).

*Remarks.*—Two specimens of *Diplocheila major* from Knox and Kosciusko Counties, Indiana have a pronotal shape typical of the Gulf Coast population, *major melissisa;* in tibial spination they lie in the zone of overlap between the typical and Gulf Coast subspecies, and their

elytral striae are impunctate. Thus they may be referred to the subspecies *major melissisa* even though they occur within the range of the typical subspecies.

*Distribution.*—This subspecies probably ranges westward to the 100th Meridian in the United States and southern Canada at low altitudes, and southward to the vicinity of the Gulf Coast.

I have collected one specimen of this subspecies in a mixed deciduous woods with a moist ground cover, in Summit County, Ohio.

Seventy males and ninety-six females collected in the following states have been examined.

Peripheral localities—New York: Niagara County, Olcott. Connecticut: Hartford County, Suffield. Iowa: Henry County, Mount Pleasant. South Dakota: Brookings County, Volga. Additional states and provinces—Illinois. Indiana. Kansas. Michigan. Minnesota. Missouri. Nebraska. Ohio. Ontario. Pennsylvania. Rhode Island. Wisconsin.

**Diplocheila major melissisa** new subspecies

*Diplochila major* Casey [in part], 1913: 148.—Leng, [in part], 1915: 579.
*Diplochila laticollis* Leng, [in part], ibid.

The diagnostic characters of this subspecies are: anterior margin of the pronotum more deeply concave than in *major,* sides constricted in front of middle, not rotund, and elytral striae generally impunctate. In addition, the number of spines in the posterior median row of the hind tibiae does not exceed two.

*Description.*—Type, female. Clewiston, Hendry County, Fla., April 7, 1937; (Harvey I. Scudder, at light). Female. Length 17.3 mm., width 7.9 mm. Luster and sculpture as in the typical subspecies.

Frontal impressions of head deep, oblong-oval pits, extending posteriorly a short distance beyond anterior margin of eye. Eyes of average convexity.

Pronotum with sides arcuate, slightly constricted basally, appearing to be more strongly constricted anteriorly than in *D. major major;* anterior margin more deeply concave than in *m. major,* median longitudinal impression shallow, extending full length of pronotum, anterior transverse impression very faintly indicated a short distance either side of median impression; posterior lateral linear pits slightly sinuate (fig. 46).

Elytra with striae 1-5 moderately deeply impressed, impunctate, stria 6 finer and somewhat shallower than 1-5. Stria 7 faintly indicated in anterior and posterior 1/4 (excluding apical 1/5), more strongly indicated medially, but finer than 6. Intervals flat, 3 of each elytron with a single puncture. Retractile stylus not studied.

Allotype.— Male. Same data as for type.

Length 16.1 mm., width 7.3 mm. Differs slightly from type in relative proportions. Frontal impressions of head consisting of a pair of pits on either side, the anterior one of each pair deeper, the posterior faintly indicated. Pronotum as in type. Elytra as in type.

Genitalia not studied.

*Variation.*—The paratypes agree closely with the type in general appearance. Data on variation in length, width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. Frontal impressions vary as in the typical subspecies.

The elytral striae are feebly punctate in a few specimens from localities scattered over the range of this subspecies. Stria 7 is completely absent (excepting deepened portion in apical 1/5) in some specimens.

*Synonymical Notes.*—Casey's concept of *D. major* Le C. was based on a single specimen from Louisiana. However, this specimen belongs to the subspecies named here. Leng also recorded the Florida specimens which he examined as being typical *major*. I have seen most of the specimens which Leng referred to *laticollis* Le C. from Florida, and all appear to belong to this new subspecies. A single specimen, from Enterprise, Florida, in the United States National Museum collection, bears a label with the unpublished name *Rembus floridanus* Schaeffer on it.

*Distribution.*—This subspecies is known from Texas, westward as far as Dallas, and southward on the Gulf Coast as far as Port Arthur; eastward through southern Louisiana, southern Alabama, and Florida; southward to Miami, and Cuba, in the Greater Antilles.

I have taken one specimen at Myakka River State Park, Sarasota County, Florida. This individual was found at the edge of a temporary pond under a mat of water hyacinth, and when disturbed it ran into the water, behaving like a hydrophilid.

Twenty-nine males and forty-seven females, paratypes, collected in the following localities, have been examined. The type and allotype are in the collection of the Museum of Comparative Zoology, paratypes are in the collections of the following institutions: American Museum of Natural History, Museum of Comparative Zoology, United States National Museum, Cornell University.

ALABAMA: Mobile County; Mobile. CUBA: County not determined—Camoa Habane, Somorrostio. Range of dates of collection: March 10-April. FLORIDA: Brevard County—Rockledge; Dade County—Bisc. Bay, Miami, South Miami; Glades County—Moore Haven; Hendry County—Clewiston, LaBelle; Indian River County—Sebastian; Lee County—Ft. Myers; Palm Beach County—L. Worth; Putnam County—Crescent City; Range County—Orlando, Winter Park; Saint Johns County—St. Augustine; Sarasota County—Sarasota; Seminole County—Osceola, Sanford; Volusia County—Enterprise, Ormond; County not determined—Capron, Hanover. Range of dates of collection: January 5-May 25. LOUISIANA: Orleans County—New Orleans; Saint Tammany County—Covington; Vermilion County—Gueydan. Range of dates of collection: February 2-October 26. TEXAS: Dallas County—Dallas; Jefferson County—Port Arthur. June 6.

TABLE 16

COEFFICIENTS OF DIFFERENCE BETWEEN SAMPLES OF *D. major* AND *assimilis* FOR LENGTH IN MM.

| | *m. major* | *m. melissisa* | *a. planulata* |
|---|---|---|---|
| | Males | | |
| *a. assimilis* ..... | 3.46 | 3.29 | |
| *m. major* ..... | | 0.41 | |
| | Females | | |
| *a. assimilis* ..... | 2.75 | 2.83 | 0.63 |
| *a. planulata* ..... | 2.43 | 2.42 | |
| *m. major* ..... | | 0.54 | |

**Diplocheila (Isorembus) obtusa** Le Conte

*Rembus obtusus* Le Conte, 1848: 420, [type specimen a female, in the Le Conte Coll., MCZ no. 5706]. Type locality: Long's Peak (Colorado) determined from original description).

*Diplochila obtusa* Horn, 1880: 52.

*Diplocheila obtusa* Casey, 1920: 200 and 205.

*Diplocheila parallela* Casey, 1920: 204 [type specimen a female, in Casey Coll., USNM no. 47383]. Type locality: Homer, Illinois; (determined from original description).

*Rembus parallelus* Lindroth, 1954: 136.

This species and the following one, *D. undulata* Carr, form a distinct unit within the *striatopunctata* group, the distinguishing features of which are: pronotum with posterior angles distinctly and broadly rounded, anterior margin relatively deeply concave, and sides almost parallel (figs. 46 and 47). In addition, elytral interval 3 is usually impunctate.

*D. obtusa* may be separated from *D. undulata* by the characters presented in the key.

*Description.*—Type, female. Long's Peak.

Length 10.5 mm., width 4.7 mm. Surface glossy, sculpture as described for *striatopunctata* group.

Frontal impressions of head small round pits. Eyes moderately convex, less so than in *striatopunctata.*

Pronotum with anterior margin relatively deeply emarginate (said by Le Conte to be shallowly emarginate but compared with the other species of the genus, the emargination is deep), sides slightly rounded, more strongly incurved anteriorly than posteriorly; disc convex, declivous laterally, impressions average for group; posterior lateral impressions narrow, elongate (fig. 46).

Elytra with intervals flat, striae distinctly impressed, impunctate, stria 7 somewhat finer and shallower than 1-6. Interval 3 impunctate.

Retractile stylus not studied.

*Variation.*—Data on variation in total length, maximum width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. Frontal impressions of the head are broad and shallow, generally irregularly rounded in outline, although elongate in some specimens. The pronotum is usually as in the type, but the sides are more parallel and less strongly rounded in some specimens. The posterior lateral impressions attain the basal margins in a few specimens, but usually they are not that long.

The basal portion of stria 1 varies from completely absent to weak but visible, and never contacting the sutural portion of stria 1. Striae 1-5 are moderately deep in all specimens examined, 6 is slightly finer, and 7 is still finer. The elytral intervals vary from flat to slightly convex. Interval 3 is punctate in one specimen from Edmonton, Alberta.

The female stylus and median lobe of the male genitalia are like those of *striatopunctata* (1 male and 1 female dissected and studied).

*Synonymical Notes.*—The synonymy presented here was proposed by Lindroth (1954). The differences between the type of *parallela* and supposedly " typical " specimens of *obtusa* are characters that vary individually and are, therefore, not significant from a systematic standpoint. The slight size difference between the type of *parallela* (length 9.6 mm., width 4.4 mm.) and that of *obtusa* (length 10.5 mm., width 4.7 mm.) is not significant.

*Distribution.*—This species is transcontinental in the Northern Coniferous Forest—or at least along the waterways in this area, ranging northward at least to McMurray, Alberta (57° + N. lat.), from British Columbia to Nova Scotia, southward in the east at least to Pennsylvania, in the middle west to southern Kansas (east of the 100th Meridian) and southward in the Rocky Mountains to New Mexico.

I have collected this species in Chautauqua County, New York and at McMurray, Alberta. In both areas the specimens were found under stones on moderately dry soil within twenty-five or thirty feet of a stream margin.

Thirty-six males and forty females collected in the following states have been studied.

Peripheral localities—Quebec: Como. Massachusetts: Plymouth County, Plymouth. Pennsylvania: Dauphin County, Harrisburg. New Mexico: Sandoval County, Jemez Mountains. Washington: Spokane County, Spokane Falls. Alberta: McMurray. Additional states and provinces—British Columbia. Colorado. Indiana. Iowa. Kansas. Michigan. Minnesota. Missouri. Nebraska. Nevada. New York. Ohio.

**Diplocheila (Isorembus) undulata** Carr

*Diplocheila undulata* Carr, 1920: 218; [type specimen a male, in the collection of the Canadian Department of Agriculture, Ottawa, Ontario]. Type locality: Edmonton, Alberta, Canada (determined from label on type specimen).

The distinguishing features of this species are presented in the key.

*Description.*—Paratype, male. Edmonton, Alta., 27-4, 1918 (F. S. Carr); [Carr Coll., Univ. of Alta., Edmonton, Alberta].

Male. Length 12.1 mm., width 5.3 mm. Surface glossy, microsculpture as described for *striatopunctata* group. Surface of head, pronotum, lateral and ventral thoracic sclerites, and abdomen average, elytra with intervals interrupted by shallow, transverse wrinkles, especially noticeable along striae, giving the elytra a corrugated appearance.

Frontal impressions of head shallow, elongate, and sinuate foveae. Eyes moderately convex, less so than in *striatopunctata.*

Pronotum with anterior margin deeply concave, sides rounded throughout their length, incurving more strongly anteriorly than posteriorly; posterior lateral angles broadly rounded; disc slightly convex; impressions average for genus. (See fig. 47).

Elytral intervals moderately convex. All striae distinctly impressed but 7 slightly shallower than 1-6. Interval 3 impunctate.

Male genitalia not studied.

*Variation.*—Data on variation in total length, maximum width, and number of spines in the posterior median row of the hind tibiae are presented in tables 17-19. Frontal impressions of the head vary slightly in extent. The sides of the pronotum are usually less broadly rounded, thus more parallel, and the anterior margin is less deeply concave than in the specimen described above. Elytral intervals vary from moderately convex to almost flat. In specimens from Alberta and N. Ill. the striae are shallower and there are fewer crenulations than in specimens from Makinak, Manitoba in which the elytra are about the same as in the specimen described above.

Retractile stylus of the female and male genitalia as in *striatopunctata* (1 male and 1 female dissected).

*Distribution.*—This species ranges from " Northern Illinois " northward in the Plains area to Edmonton, Alberta.

Three males and eight females, collected in the following localities, have been examined.

ALBERTA: Edmonton, April 27-July 27. ILLINOIS: " Ill." " N. Ill." MANITOBA: Makinak.

TABLE 17

*Diplocheila striatopunctata* group: Variation in Total Length (mm.).

| Species | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | | Males | | |
| *striatopunctata*[1] .... | 37 | 12.5–16.7 | 14.4 ± 0.15 | 0.93 ± 0.11 | 6.5 |
| *striatopunctata*[2] .... | 37 | 12.9–16.9 | 14.9 ± 0.13 | 0.78 ± 0.09 | 5.3 |
| *oregona* ..... | 22 | 10.5–12.6 | 11.6 ± 0.12 | 0.56 ± 0.08 | 4.8 |
| *modesta* ..... | 26 | 10.9–12.8 | 12.0 ± 0.10 | 0.53 ± 0.07 | 4.4 |
| *a. assimilis* ..... | 45 | 11.1–14.4 | 13.0 ± 0.11 | 0.84 ± 0.09 | 6.4 |
| *a. planulata* ..... | 4 | 14.4–15.2 | 14.9 | | |
| *nupera* ..... | 3 | 9.9–11.3 | 10.6 | | |
| *m. melissisa* ..... | 22 | 14.9–18.6 | 17.0 ± 0.11 | 0.52 ± 0.07 | 3.1 |
| *m. major* ..... | 24 | 16.3–19.2 | 17.5 ± 0.15 | 0.74 ± 0.11 | 4.3 |
| *obtusa* ..... | 22 | 9.7–11.7 | 10.5 ± 0.09 | 0.45 ± 0.06 | 4.3 |
| *undulata* ..... | 2 | 12.2 | | | |
| | | | Females | | |
| *striatopunctata*[1] .... | 44 | 14.1–17.7 | 15.8 ± 0.13 | 0.90 ± 0.09 | 5.7 |
| *striatopunctata*[2] .... | 25 | 14.3–17.9 | 16.4 ± 0.16 | 0.80 ± 0.11 | 4.9 |
| *oregona* ..... | 15 | 10.7–13.3 | 12.3 ± 0.10 | 0.62 ± 0.07 | 5.0 |
| *modesta* ..... | 40 | 11.9–14.2 | 12.8 ± 0.10 | 0.62 ± 0.07 | 4.8 |
| *a. assimilis* ..... | 45 | 10.9–15.4 | 13.7 ± 0.13 | 0.87 ± 0.09 | 6.4 |
| *a. planulata* ..... | 10 | 13.3–15.7 | 14.7 ± 0.22 | 0.71 ± 0.15 | 4.8 |
| *nupera* ..... | 5 | 10.1–11.8 | 11.1 | | |
| *m. melissisa* ..... | 47 | 16.5–19.3 | 18.0 ± 0.09 | 0.65 ± 0.07 | 3.6 |
| *m. major* ..... | 45 | 17.1–20.7 | 18.9 ± 0.15 | 1.02 ± 0.11 | 5.4 |
| *obtusa* ..... | 28 | 9.7–11.7 | 10.6 ± 0.09 | 0.50 ± 0.07 | 4.7 |
| *undulata* ..... | 6 | 12.3–14.4 | 12.8 | | |

[1] Concolorous phase.

[2] Bicolored phase.

TABLE 18

*Diplocheila striatopunctata* group: Variation in Maximum Width (mm.).

| Species | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | | Males | | |
| *striatapunctata*[1] .... | 37 | 0.5–7.6 | 6.2 ± 0.07 | 0.44 ± 0.05 | 7.1 |
| *striatapunctata*[2] .... | 37 | 5.7–7.3 | 6.5 ± 0.06 | 0.37 ± 0.04 | 5.6 |
| *oregona* ..... | 22 | 4.5–5.9 | 5.1 ± 0.07 | 0.33 ± 0.05 | 6.4 |
| *modesta* ..... | 26 | 4.8–5.5 | 5.2 ± 0.04 | 0.22 ± 0.03 | 4.2 |
| *a. assimilis* ..... | 45 | 5.0–6.4 | 5.7 ± 0.05 | 0.36 ± 0.04 | 6.3 |
| *a. planulata* ..... | 4 | 6.3–6.6 | 6.4 | | |
| *nupera* ..... | 3 | 4.3–4.9 | 4.7 | | |
| *m. melissisa* ..... | 22 | 7.0–8.0 | 7.5 ± 0.07 | 0.31 ± 0.05 | 4.1 |
| *m. major* ..... | 24 | 7.0–8.2 | 7.6 ± 0.07 | 0.33 ± 0.05 | 4.3 |
| *obtusa* ..... | 22 | 3.7–4.9 | 4.4 ± 0.06 | 0.26 ± 0.04 | 6.0 |
| *undulata* ..... | 2 | 5.4 | | | |
| | | | Females | | |
| *striatopunctata*[1] .... | 44 | 6.3–7.8 | 7.1 ± 0.06 | 0.41 ± 0.04 | 5.8 |
| *striatopunctata*[2] .... | 25 | 6.5–7.9 | 7.4 ± 0.08 | 0.39 ± 0.06 | 5.5 |
| *oregona* ..... | 15 | 4.9–6.1 | 5.5 ± 0.07 | 0.29 ± 0.05 | 5.3 |
| *modesta* ..... | 40 | 4.9–6.2 | 5.6 ± 0.05 | 0.29 ± 0.03 | 5.2 |
| *a. assimilis* ..... | 45 | 4.9–6.8 | 6.0 ± 0.07 | 0.45 ± 0.05 | 7.5 |
| *a. planulata* ..... | 10 | 5.9–7.0 | 6.5 ± 0.11 | 0.36 ± 0.08 | 5.6 |
| *nupera* ..... | 5 | 4.2–5.1 | 4.7 | | |
| *m. melissisa* ..... | 47 | 7.3–8.8 | 8.0 ± 0.05 | 0.34 ± 0.03 | 4.2 |
| *m. major* ..... | 45 | 6.9–9.2 | 8.3 ± 0.07 | 0.45 ± 0.05 | 5.5 |
| *obtusa* ..... | 28 | 4.1–5.0 | 4.6 ± 0.05 | 0.25 ± 0.03 | 5.5 |
| *undulata* ..... | 6 | 5.5–6.3 | 5.9 | | |

[1] Concolorous phase.
[2] Bicolored phase.

TABLE 19

*Diplocheila striatopunctata* group: Variation in the Number of Spines in the Posterior Median Row of the Hind Tibiae (right + left).

| Species | N | Range | Mean |
|---|---|---|---|
| *striatopunctata* ..... | 168 | 1–10 | 5.5 |
| *oregona* ..... | 37 | 4–10 | 7.6 |
| *modesta* ..... | 66 | 0–2 | 0.7 |
| *a. assimilis* ..... | 94 | 0–3 | 0.4 |
| *a. planulata* ..... | 14 | 0–2 | 0.1 |
| *nupera* ..... | 9 | 0–2 | 0.2 |
| *m. melissisa* ..... | 72 | 0–2 | 0.1 |
| *m. major* ..... | 65 | 0–8 | 4.0 |
| *obtusa* ..... | 55 | 4–8 | 6.1 |
| *undulata* ..... | 8 | 5–7 | 6.1 |

## Phylogeny of the *Diplocheila*

The working principles used in this study are the following. Evolution results usually in divergence of closely related stocks, and only secondarily in convergence. Therefore, in evaluating morphological characters for use in tracing relationships, an arrangement must be worked out which requires a minimum of convergent evolution to explain the suggested sequence of relationships. Second, within a genus the species most likely to be closest to the ancestral stock is the one which departs the morphologically shortest distance from members of related genera, or in a group believed to be very primitive, from related tribes.

The suggested course of evolution of this genus is only one way of looking at the facts, but it seems to me to be the most likely to be correct in terms of these concepts.

Certain morphological features shared by *Diplocheila* and *Dicaelus* suggest that these two genera are phyletically closer to one another than to any other licinine genus, and these same characters, which concern the structure of the male genitalia and of the mandibles, seem to single out these genera as constituents of a rather primitive stock. Both genera have four dorsal sclerotized strips on the median lobe, and the mandibles of some of the species of *Diplocheila* present some very primitive features as they preserve both the terebral and retinacular teeth on the left mandible. The mandibles of *Dicaelus* have departed but a relatively short distance from the primitive plan. The clypeus of some species of *Diplocheila* is virtually unmodified in terms of what one ordinarily sees in the Licinini. (This latter statement applies also to the Oriental genera *Dilonchus* and *Genycerus*). I think that *Diplocheila* and *Dicaelus* are relatively closely related and that it is possible to arrive at the characters of their ancestral stock by assuming that the latter possessed the primitive features of both of its descendent genera. These characters are the following: The head probably bore two setigerous punctures over each eye. This character is not derivative because it is characteristic of most other licinines. The front was probably flat, or slightly convex, with small frontal impressions. The clypeus was probably flat, with the anterior margin either not concave or very shallowly so. The arrangement described for the front and clypeus is characteristic of most carabid groups and so is probably not derivative in the

Licinini. The labrum was probably very shallowly and angularly emarginate and probably bore six setae along its anterior margin. As all species of *Diplocheila* and *Dicaelus* and most of the species of the Licinini have at least a shallowly emarginate labrum (*Siagonyx* excluded), possibly such a character would appear in an ancestral stock. The mandibles were probably more or less trigonal, probably not flattened, the left had two teeth, the right one tooth, and the biting or inner edges were probably thin and not adapted for crushing. The ventral groove probably had relatively short hairs. The Licinini, by and large, depart widely from the great bulk of the family Carabidae in mandibular structure. Within a genus, the species with mandibles most closely approaching those of non-licinine Carabidae may be regarded as being primitive with respect to this character, and the possession of at least two teeth on each mandible is characteristic of most carabids. The paraglossae were probably broadly attached to the ligula and their lobes extended beyond the apex of the lights. The terminal palpal segments were probably slender but truncate apically. The penultimate segment of the labial palpus was probably bisetose. As this segment is bisetose in most licinine genera, it is probably a character which was possessed by ancestral Licinini. The genae were probably moderately deeply strigose as the genae of the species of both *Diplocheila* and *Dicaelus* are more or less strigose. The pronotum was probably more or less quadrate, not cordate or trapezoidal. This statement is based only on the fact that a quadrate figure is relatively simple and other types may be derived from it more easily than from other geometrical forms. The apex of the prosternum, between the front coxae, may or may not have been margined. In *Dicaelus* the margined condition is universal, whereas in *Diplocheila* it occurs in only one group of the subgenus *Isorembus*. If it was present in the ancestral species of the genera under consideration, then it was lost in the *Diplocheila* line and later regained. For the sake of this discussion it may be assumed that this feature was present in the ancestral population, retained in one line of descent, lost in the second line, and then subsequently regained. The other possibility is equally valid, i.e. that the prosternum became margined independently in both lines of descent. The metepisternum was probably elongate and the hind wings were probably fully developed. The winged condition seems to be primitive in beetles, the loss of wings

derivative. Correlated with loss of the function of flight is the shortening of the metepisternum and fusion of the elytra along the suture. The anterior tarsus of the male probably had three dilated segments clothed beneath with spongy pubescence. As the males of all species of *Diplocheila* and *Dicaelus* exhibit this character it is probable that their common ancestor did also. The first four tarsal segments (excluding the modified segments of the male) probably bore two rows of setae on each side, one row laterally and one row lateroventrally. This arrangement is widespread through *Dicaelus, Badister,* and occurs in at least the few *Licinus* that I have seen, so possibly it was characteristic of the archetype of the genera under discussion here. The claw-bearing segment of each tarsus probably had a row of setae on each ventro-lateral margin. The absence of setae on this segment can best be accounted for by assuming that they were once present and were subsequently lost. This is in keeping with the principle that similarity of all segments of a limb is more generalized than the differentiated condition, as the other four tarsal segments (except the modified ones in the males) bear at least one row of setae on each ventro-lateral margin as was pointed out above. The elytra were probably moderately deeply striate with the scutellar stria not joined to the sutural portion of stria 1 and the basal portion of stria 1 present. Within the Carabidae the usual condition seems to be striate elytra with the striae of moderate depth, and other conditions may be thought of as specializations. Striae 8 and 9 were probably not close together, and the apical portion of stria 7 was probably not deeper than the more basal portion. In Carabidae generally and Licinini particularly, stria 8 and 9 are moderately widely separated so that this must be the generalized condition. The same argument applies to the deepening of the apical portion of stria 7. Elytral interval 3 was probably impunctate. In *Diplocheila* the punctate condition occurs in two relatively specialized lines of descent, in *Dicaelus* not at all. Interval 7 was probably not carinate. The development of an elytral carina, although not confined to *Dicaelus,* is not a very common feature in the Carabidae, and so it is probably a derivative feature in the Licinini. The median lobe of the male genitalia was probably simple apically, without a dorsal hook, and the internal sac was probably devoid of spines and plates, excepting a pair of apical plates. The development of a dorsal hook in *Dicaelus* may be regarded

as a specialization, as this is not a feature very common in the Carabidae, whereas the opposite condition is widespread and so may be considered more primitive. The development of spines on the internal sac is probably also a specialization for the same reason. The female retractile stylus was probably more or less boomerang-shaped. This form seems to be of common occurrence in the Carabidae. I assume it is the generalized condition and that other forms are specialized. The 6th abdominal sternite probably bore two setae in the males and four setae in the females, and the 1st to the 5th sternites probably bore one pair of ambulatory setae each. Again, this is the condition most commonly encountered in the Carabidae.

Whether a species population exhibiting this combination of characters existed or not it is impossible to say. If it did exist today we would regard *Diplocheila* and *Dicaelus* as subgenera of a single genus. Anyway, I postulate that a species or group of closely related species possessing these characters did exist, and that it was the archetype of Group 1 of the Licinini, and that its extant descendents are placed in the genera *Diplocheila* and *Dicaelus*. I doubt very much that this group of licinines arose from any of the now extant licinine stocks or even that it is very closely related to any of the other living Licinini.

Diagram 1 at the end of this section summarizes graphically the views presented here on the relationships of the species of *Diplocheila*. The numbers on the diagram are referred to in the text.

If a species or species group having characters such as those outlined above (Ancestor 1) gave rise to a population which differed or was distinctive only in having the dorsal surfaces uniformly micropunctulate, an un-margined prosternum, elytral striae 8 and 9 very close together, and stria 7 very deep apically and separated from 8 by a narrow carina, we would place such a form in the genus *Diplocheila*. A species such as this does not exist, but it does not seem impossible or improbable that it could have existed in the past. As a postulate we may regard this set of features as characteristic of the ancestral stock of the living species of *Diplocheila* (Ancestor 2). A species with the combination of characters mentioned above, i.e. those of the ancestral population of "Group 1" as modified to produce the genus *Diplocheila*, could have given rise to the common ancestor of the subgenus *Diplocheila* and *Neorembus* by these changes: development of long, dense

hair in the ventral mandibular groove; reduction of setae on tarsal segments 1-4 on each lateral margin (ventro-lateral row preserved), and loss of setae from the ventro-lateral margin of the claw-bearing tarsal segment (Ancestor 3). The only modification required to arrive at the ancestral stock of the subgenus *Diplocheila* is the broadening of the apices of the labral lobes (1). The resulting species may have produced two stocks, in one of which the scutellar stria became joined to the sutural portion of stria 1, and the basal portion of stria 1 atrophied, and the number of labral setae were reduced to four (2). Such a species may itself have given rise to two lines of descent, in one of which the teeth of the left mandible became reduced and the labral lobes became elongate (3), thus giving rise to *daldorfi.* In the other development of this lineage the female styli became broadened (4). This line may have produced two species: *D. colossa,* with no change from the condition described in (4), and *exotica,* which developed elongate labral lobes (as in *daldorfi*), shallower elytral striae, and a glossier integument (5).

Returning to (1) and following the genealogy of the *polita* group, I postulate that the characteristics developed by the ancestral stock of this group were: loss of micropunctation on the dorsal surface, loss of 1 supraorbital setigerous puncture over each eye, specialization of the female stylus by broadening and shortening, and broadening of the terebra of the mandibles (6). This stock produced a series of three closely related species; *indus, laevigata* and *laevigatoides.* This differentiation is marked by modifications of the female retractile stylus, median lobe of the male, and proportions of the clypeus and labrum. On the basis of labral and clypeal structure *laevigata* would seem to be most primitive, with *indus* most derivative. The absence of punctures from the elytral striae would seem to indicate that *laevigatoides* is most derivative. The presence of carinae on the dorsal surface of the female stylus of *indus* would indicate this species to be most derivative with respect to this character. The evidence bearing on this problem seems to be conflicting at least to some degree. An earlier differentiation of the same stock which produced the three species discussed above may also have given rise to the remaining species included in the *polita* group. The modifications involved may have been: loss of two labral setae; reduction of the basal portion of the female stylus; ventral sur-

face of the median lobe becoming convex. These are the essential characters of *polita*. From this stock another line developed characterized by the reduction in depth of the labral concavity (8). This species probably became divided into three populations. One of these, which was characterized by increase in size, gave rise to *elongata* (9). A second, in which rather prominent posterior angles of the pronotum were developed, was the ancestor of *quadricollis* (10). The third population, which may have been distinguished by a more elongate antennal scape, gave rise to *distinguenda* (11). These species are also distinguished by details of shape of the female stylus.

Returning to Ancestor 3, a series of modifications of a portion of this stock may have produced a species in which the frontal portion of the head became widened, the mandibles lengthened, became more slender and edentate, and the stylus of the female became broadened (12). A species with these characteristics is recognizable as *Neorembus latifrons* which probably gave rise to the island subspecies *l. darlingtoni*, which developed proportionately longer mandibles, and apparently a somewhat different pattern of growth (13).

A second differentiation of the stock of Ancestor 2 may have produced the ancestral population of the subgenus *Isorembus*. Probably the development of a prototype of this subgenus involved these changes: front and clypeus became concave, the anterior margin of the clypeus became strongly concave, the labrum became reduced in width, lost two setae, became asymmetrically emarginate; the inner margin of the left mandible became edentate, the basal area became molariform, and the terebral tooth of the right mandible became molariform (14). These are the essential characteristics of the extant members of the *zeelandica* group. Differentiation of this stock may have produced a species with highly polished integument, shallow elytral striae, with only a single row of setae on tarsal segments 1-4, and having two setae on the 6th abdominal sternite of the male, four on the female (15). This is the species *laevis*.[7] A second stock which may have developed, retained the primitive characters of the group, excepting that extra setae were developed on the 6th abdominal sternite to yield a total of four in the

[7] The species *macromandibularis* cannot be accurately placed in this scheme at present because I lack knowledge of certain of its structural features. However, on the basis of what I do know about the morphology of this species, I suggest that it should be placed between the *laevis* and the *pinodes-zeelandica* lines.

males and six in the females (16). A species with such characters may have given rise to *zeelandica* and *pinodes*, *zeelandica* developing a broader stylus in the female, and *pinodes* a broad tooth near the apex of the stylus.

At an earlier time than the differentiation of the living species of the *zeelandica* group, the ancestral stock of the subgenus *Isorembus* may have given rise to another stock in which the setae on tarsal segments 1-4 were reduced to a single row on each side (ventro-lateral row), the basal portion of stria 1 became weakened, and the sutural portion of 1 and scutellar stria joined, a puncture developed in interval 3, the blade of the female stylus became widened, and the number of setae on the stylus was reduced (18). An early divergence of this stock may have produced two lines of descent which ultimately resulted in the development of the extant species now included in the *aegyptiaca* and *striatopunctata* groups. One of these stocks is characterized by the loss of one supraorbital setigerous puncture, the complete atrophy of the basal portion of stria 1, and the development of a fusiform boss on the cutting edge of the left mandible near the base of the terebra (19). Possibly the ancestral stock is represented today by *transcaspica.* A second product of this lineage is *aegyptiaca,* in which species the terebral edge atrophied so that the cutting edge consisted solely of the retinacular ridge, and the terebral boss became reduced in size (20). In a third species, *cordicollis,* the dorsal surface of the mandibles became deeply strigose and the pronotum became constricted basally, thus cordate in shape (21).

The ancestral stock of the *striatopunctata* group probably had a common ancestry with the prototype of the *aegyptiaca* group, diverging from the latter by the reduction of the micro-punctation of the head, the loss of the ventro-lateral setae on the claw-bearing tarsal segment, the loss of all setae from the female retractile stylus, and the elongation of the membranous portion of the 8th sternite. The base of elytral stria 1 in a very weakened condition was probably retained (22). An early differentiation of this stock probably produced a species in which the puncture in elytral interval 3 was lost and the posterior lateral angles of the pronotum became broadly rounded (23). Two species may have been produced by this line: *undulata,* in which the pronotum and elytral intervals became more convex and the elytral intervals crenulate (24); and *obtusa,* without modification of the basic stock.

The main line of descent produced finally an assemblage of six species, the most poorly differentiated to be encountered in the genus. The diagram suggests how they may be related. Probably *oregona* and *striatopunctata* are more closely related to one another than either is to any other species. *Oregona* is derivative in that the members of this species have lost the micropunctulation of the dorsal surface and the puncture in elytral interval 3, also the elytra are relatively coarsely microgranulate. This species is primitive in that a considerable proportion of the individuals have the basal portion of stria 1 relatively well preserved and, in a few specimens, the scutellar stria is not joined to the sutural portion of stria 1. The elytra of *striatopunctata* are also rather coarsely microgranulate and the puncture is absent in a fair percentage of the members of this species. The remaining species are all very closely related, and there is some question as to whether or not *modesta* is actually specifically distinct or conspecific with *assimilis*. Probably these species had a common ancestry with *striatopunctata*. All except *major major* differ from the other species of this group in having a much lower average number of spines in the posterior median row of the hind tibiae. The average number for *major major* is slightly lower than the other species. *Assimilis, major,* and *nupera* exhibit a distinct tendency toward reduction of elytral striae, especially stria 7. This tendency is not so clearly marked in *modesta*. These species are quite similar in pronotal shape, but *modesta* and *major major* differ from the others in that the sides are more rotund in front of the median transverse plane. *Assimilis* is of intermediate size, *nupera* is small, and the members of the species *major* are large. The species may be aligned, from a phyletic point of view, in one of two ways depending upon how characters are weighted. If we assume that *modesta* is more primitive because it has a well developed elytral interval 7, then we can easily derive *assimilis* and *nupera* from it, and *major* probably through *assimilis*. On the other hand, if we assume that the high average number of tibial spines is more important, then *major* must be put at the bottom and from it we derive the other three species. Because of an acute shortage of good morphological characters it is virtually impossible to come to any kind of conclusion. The matter will be discussed in further detail in the following section which deals with zoogeography.

A certain amount of convergence seems to have taken place in the genus, provided that the pattern of genealogy suggested here is approximatly correct. The number of supraorbital setae over each eye has probably been reduced from two to one, twice. The number of setae on the dorsal surface of the labrum has probably been reduced to four, three times. The lobes of the labrum have probably become elongate four times. The basal portion of elytral stria 1 has probably been

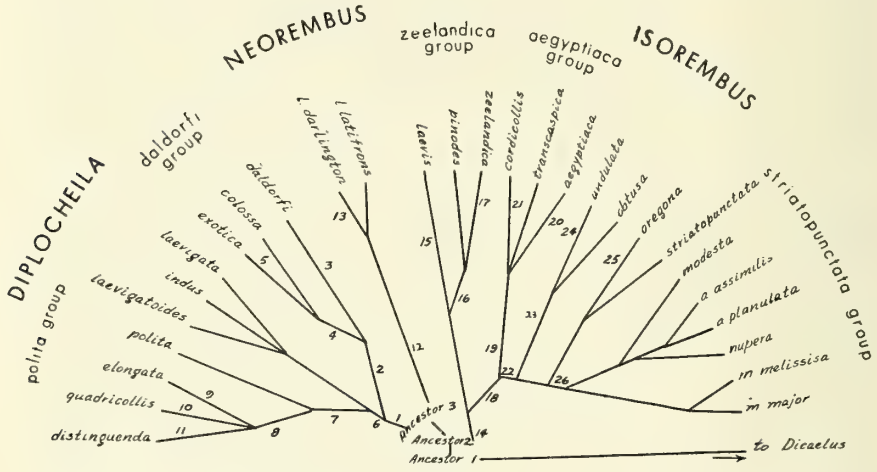


Diagram 1.—A diagrammatic representation of the structural relationships and possible phylogeny of the species of *Diplocheila.*

lost at least twice, and simultaneously the scutellar stria has become attached to the sutural portion of stria 1. The female retractile stylus has probably been broadened four times but each time in a slightly different way. Micropunctation of the dorsal surface has probably been lost twice.

## Zoogeography of the Genus *Diplocheila*

Distributional data of a geographical nature are most useful in interpreting the history of forms which are largely allopatric, and become progressively less useful as sympatry increases. The assumption implicit in this line of reasoning is that speciation is a process which requires spatial isolation of originally conspecific populations, and when the closely related species are wholly, or in part, sympatric, then the barrier which originally prevented their contacting one another, or exchanging genes, and enabled them to differentiate has been removed or in some way circumvented. Thus when two species are completely sympatric, part of their past history has been lost to us. To interpret the possible past history of forms which are completely sympatric in a geographical sense, it is necessary to consider their ecology and to find clues there to their past distribution.

The general distribution of the licinines suggests that the center of dispersal of the tribe was very likely the Old World, and probably the southern portions of the Eurasian continent. I think it likely that the ancestral stock of Group 1 of the Licinini originated somewhere in the Old World Tropics, possibly in Late Cretaceous time. One branch of this stock may have dispersed in early Tertiary time via the Bering Land Bridge to the New World, and perhaps became extinct in the Old World. This was the ancestral stock of *Dicaelus*. A second derivative of this stock may have been the ancestor of the genus *Diplocheila* which may have differentiated early in the Tertiary to give rise to the three living subgenera.

The subgenus *Diplocheila* (*s. str.*) is now known only from the Oriental Region and the eastern Palaearctic. Both groups of living species occur over the whole of the Oriental Region, but the *daldorfi* group is not represented in the temperate part of China and Japan. Probably both groups had their origin in southeastern Asia but it is not profitable to speculate further at this time because this area is so poorly collected and the ranges of the species are therefore poorly understood.

The subgenus *Neorembus* may have originated in southern China, for it is in this area that the forms with the least specialized labrum occur. A dispersal of this species southward into southern Asia, India, and the Malay Archipelago may have taken place and possibly the Philippine Islands may have been invaded, probably over a water bar-

rier. The Philippine Islands population subsequently differentiated from the mainland and Indo-Australian stocks, producing the subspecies *darlingtoni.*

Originating in southeast Asia, the *Isorembus* ancestral stock may have early differentiated into two lines. One of these remained in the area of origin and gave rise to the living species of the *zeelandica* group. The other line dispersed out of the center of origin, one segment moving westward to Persia and Africa, the other going northward and ultimately eastward across the Bering Land Bridge to North America. The details of the distribution of the species of the *zeelandica* group are not sufficiently clear to warrant speculation at this time.

The ancestral stock of the *aegyptiaca-striatopunctata* group spread out of southeastern Asia and eventually withdrew from the Oriental Region altogether, giving rise to the species of the *aegyptiaca* group in the west and the species of the *striatopunctata* group in North America. The *aegyptiaca* group stock probably dispersed to Africa and may also have invaded northern India, or else may actually never have completely withdrawn from this area, or may have withdrawn from the tropical areas and reinvaded the temperate portions. In any event, there are three species today, one of which is in Africa, one in northern India, and one in Iran and the transcaspian provinces of the U.S.S.R. The least derivative of the three is *transcaspica.* Possibly, then, this represents the ancestral population from which the Indian and African elements were derived.

The ancestral stock of the *striatopunctata* group may have been cool-adapted, moving northward along the eastern edge of the Palaearctic to the Bering Strait and crossing over into North America, possibly as late as Pliocene time when the Northern Coniferous Forest was growing in northern Alaska, dispersing eastward through the forest, probably mainly via the water courses. Probably all of the species of the *striatopunctata* group represent a single incursion from the Old World, as all are quite, and some very, closely related. Probably speciation of this stock has taken place in the Pleistocene, the necessary spatial isolation being caused by climatic and resulting floral shifts which probably occurred. The distribution of the species is as follows. *assimilis* and its allies do not range west of the Rocky Mountains nor do they extend northward into the Northern Coniferous Forest. Two of them, *nupera*

and *major*, are represented in Florida, and *major* even occurs in the Greater Antilles. *striatopunctata* and *obtusa* are transcontinental in the Northern Coniferous Forest and range southward east of the 100th Meridian, *striatopunctata* to Georgia, and *obtusa* to Pennsylvania, at least, and probably farther. *oregona* and *undulata* are primarily northern and western in distribution with *undulata* ranging as far east as Illinois, and westward and northward to Edmonton, Alberta. *oregona* occurs in northwestern Oregon, southern Alberta, Saskatchewan, Manitoba, and in Nevada and Utah.

The species occurring only in United States and southern Canada east of the Rockies all seem to be very close and all have probably been derived from a common stock. Probably the ancestor of this lineage was isolated in eastern North America from a western portion of the same stock which gave rise to *striatopunctata*. *assimilis* and *major* are almost completely sympatric, and the range of *modesta* is included within the ranges of the other two species. All seem to be found in the same general areas. At least *assimilis* has been taken with both *modesta* and *major*, but I do not have any records of *major* and *modesta* being taken in the same habitat. As I do not know anything about habitat preference of these species, clues to their history cannot be derived from ecology. A Pleistocene Floridian peninsula might have been invaded by a segment of the *assimilis* population during a glacial period, to be isolated there during an interglacial when most of the peninsula was submerged, giving rise to the species *nupera*. The invasion of Cuba by *major melissisa* was probably over a water barrier, possibly during a late glacial period when the gap between Florida and Cuba was not as extensive as it is today. The differentiation of *assimilis* and *major* into two geographical races each may be post-Pleistocene.

Possibly the ancestral stock of *striatopunctata* and *oregona* became divided into two segments during a glacial period. The eastern segment may have given rise to *striatopunctata*, the western, to *oregona*. With the termination of that particular glacial period, *striatopunctata* was able to move westward, thus eventually coming to broadly overlap the range of *oregona*. Subsequently, a mutation causing the "*alternans*", or bicolored color phase of *striatopunctata*, occurred in the east or middle west (probably the latter), and the mutation has not yet spread to the west. Possibly the differentiation of *obtusa* and *undulata*

can be accounted for in the same terms as those postulated for *striatopunctata* and *oregona*.

No geographical explanation of the differentiation of the *obtusa* stock is offered because of the lack of sufficient information to interpret the distribution pattern.

## Genus **DICAELUS** Bonelli

The most obvious diagnostic features of this genus are presented in the key. Features common to all of the species are given in the following description.

*Description.*—Head usually slightly broader in the females than in the males, with two supra-orbital setigerous punctures over each eye. Clypeus emarginate anteriorly, deflected ventrally slightly more than the slope of frontal portion of head, bearing anteriorly a single long seta on each side. Labrum approximately trapezoidal in outline, varying at base from about 1/3 to about 2/3 the wdith of clypeus, shallowly and angularly incised anteriorly, slightly asymmetrical, bearing a transverse row of six setae near anterior margin, three each side of median longitudinal groove. Segments of maxillary palpi average, terminal segment triangular with apex obliquely truncate. Terminal segment of labial palpus usually more broadly triangular when homologous segment of maxillary palpus, and apex obliquely truncate. Antennae of average length with pubescence beginning on segment 4.

Pronotum wider than head, trapezoidal, transverse, at least one pair of setigerous punctures on each side, one at each posterior angle, and one on each side just inside lateral margin, about half way between base and apex; reflexed portions and sides widening slightly from apex to base and usually more shining than rest of pronotum; hind angles slightly rounded, obtuse, posterior margin emarginate in median 1/2; apex of prosternum obtuse, distinctly beaded, glabrous. Legs average, posterior tarsi distinctly shorter than posterior tibiae, not sulcate medially; terminal, or claw-bearing segment of all tarsi with a row of setae on each ventro-lateral margin; anterior tarsi of male with segments 1-3 dilated and with " spongy pubescence " on ventral surface. Segments 1-4 usually with 2 rows of setae laterally.

Elytra oblong, solidly joined along suture, wider than thorax at widest point, apical margins rounded and entire. Hind wings atrophied.

Abdominal sternites 2-5 with a transverse impression on either side; 6th sternite apically subtruncate in female, obtusely but more narrowly rounded in male, bearing on ventral surface near apical margin a variable number of setigerous punctures, usually more in females than males for a given species.

Male copulatory organs: Median lobe with shaft moderately arched; basal bulb curved ventrally, forming about a right angle with shaft at point of juncture; ventral margin of shaft more or less sinuate in lateral aspect, ventral and

lateral surfaces, and apical and basal portions of dorsal surface sclerotized; dorsal surface largely membranous with four sclerotized strips, the lateral two arising from lateral surface of shaft about half way between base and apex of shaft, median pair of strips usually narrower than lateral pair and arising one from each lateral strip; armature of internal sac consisting of a pair of lightly sclerotized apical plates and 3-6 spines. Left lateral lobe large, oval, right more slender than left and slightly shorter, but not digitate.

Female retractile plates: Stylus generally elongate and falcate, bearing one or two broad spines along inner posterior margin, and one spine at base on outer side.

*Distribution.*—This genus is restricted to North and Middle America, ranging from southern Canada east of the Rocky Mountains, and on the eastern slopes of the Rockies southward in the west to the vicinity of Mexico City, on the Mexican Plateau, and to Key Largo, Florida in the east, and westward in the southwestern United States to Utah and Arizona.

*Structure of the Mandibles in Dicaelus.*—Zimmerman (1869: 246) was the first student to point out the value of mandibular characters as an aid in identifying the species of this genus. This work was either ignored or overlooked by more recent students, probably because the species could be reasonably well identified without resorting to study of the mandibles.

Within this genus four types of mandibles are discernable which differ from one another in relative proportions of various areas, relative development of the retinacular ridge, presence or absence of a thickened basal area (determining the presence or absence of a molar), and presence or absence and extent of surface depressions, prominences or ridges. As is customary for this tribe, the right and left mandibles differ from one another.

Type I: The left and right mandibles are more similar in structure in this type than in any of the others. Two subtypes occur within this category. In one of these the inner basal margin is not thickened, subtype a, and in the other this margin is thickened and molariform, subtype b. Left mandible with dorsal surface smooth; terebra with a broad shallow depression bordering terebral margin; terebral tooth broad and prominent, terebral margin strongly concave in a horizontal plane, 0.42 of the total length of inner edge; retinacular ridge well developed, separated from terebral margin by a deep groove; basal margin

in dorsal aspect curving evenly and obliquely medially from terebral tooth to posterior basal margin; in lateral aspect, molar margin lies beneath plane of retinacular ridge and is thin edged, not thickened to form a molar tooth (subtype a) (figs. 83a and b); or molar margin dilated a short distance behind terebra to form a molar tooth, and thickened in lateral aspect (subtype b) (fig. 90a). Right mandible with terebra dorsally somewhat broader than terebra of left mandible, terebra 0.39 ± of the total length of inner edge, tooth prominent, retinacular ridge broad, broadly concave, much less prominent than terebral margin; groove separating terebral margin and retinacular ridge of moderate depth; molar margins as in left mandible in subtype a but more strongly oblique; dorsal outer margin basally not produced outward into a prominent obliquely angled ridge (figs. 83c and d).

The mandibles of *elongatus*, *l. laevipennis*, *l. abbreviatus*, and *suffusus* may be classified as Type Ia; those of *l. dicaeloides*, *l. flohri*, and *chermocki* as Type Ib.

Type II: This type is found in the subgenus *Dicaelus* (*s. str.*). Two subtypes are recognized; IIa, in which the molar area of the right mandible does not have an accessory tooth and IIb, the right mandible having an accessory tooth. Left mandible with proximal portion of terebra rugulose and opaque, distal portion micro-granulate, opaque, basal portion glossy; terebral margin rather shallowly concave, 0.53 times the length of inner margin, with a slight prominence about midway between base and apex of terebra; retinacular ridge feebly indicated, marking ventral margin of biting edge, space between dorsal and ventral margins flat, not concave, forming thus a broad surface; molar area slightly above dorsal surface of rest of basal area, sinuate in dorsal aspect, sloping obliquely medially from termination of terebra to posterior basal margin; molar area molariform in lateral aspect, as broad as distal lateral surface and broadly continuous with it (figs. 85a and b). Right mandible as in Type Ia, terebral margin 0.26 of length of inner margin, terebral tooth broader and blunter and more prominent, distal biting surface flat, not grooved medially, proximal surface without an accessory tooth in Type IIa (figs. 85c and d), with an accessory tooth in Type IIb (fig. 88b).

Mandibles of Type IIb are exhibited by *Dicaelus costatus*, and the remaining species of the subgenus *Dicaelus* have mandibles of Type IIa.

TYPE III: The elongate terebra is distinctive of this type, and is characteristic of *Dicaelus dilatatus*, *sculptilis*, and *furvus*. The mandibles of *furvus*, although similar in general to those of the former species, differ in detail, and thus two subtypes of Type III may be recognized, subtype a and subtype b. Subtype a—terebral margin of left mandible moderately concave in a horizontal plane, 0.58 times in length the total length of the inner margin, proximal portion of terebra and distal portion of base rugulose dorsally; terebral tooth very weakly indicated at posterior junction of terebral margin and retinacular ridge; retinacular ridge prominent, slightly more so than terebral margin, and separated from latter by a deep groove; molar margin joining terebral margin at a slightly oblique angle, almost evenly continuing curve of terebra, molar margin raised above plane of dorsal surface, median surface broadened, molariform (figs. 86a and b). Right mandible with terebra broader than left, terebral margin 0.53 of the total length of inner margin, terebral tooth sharp and very prominent, retinacular ridge moderately well developed, separated by a broad groove from terebral margin; base as in Type I (figs. 86c and d). This type is characteristic of *dilatatus* and *sculptilis*. Subtype b—left mandible with terebra moderately concave, 0.52 of total length of inner margin; dorsal surface with a low protuberance near proximal juncture of terebral margin and retinacular ridge, but not itself involved in configuration of terebral margin; retinacular ridge well developed, separated from terebral margin by a deep groove; basal area as in subtype b, but not continuing terebral curve as smoothly, i.e. more abruptly prominent, and molariform (fig. 87a). Right mandible as in subtype a, terebral margin 0.42 of the length of inner edge. Type IIIb is characteristic of *Dicaelus furvus* (fig. 87b).

TYPE IV: Left mandible with a slender, curved terebra, as in Type III, but base much more prominent. The right mandible is distinctive in that the basal lateral margin is produced laterad into a broadly angled ridge, and the terebra is more strongly declivous from the terebral margin to the outer lateral margin. Three species, *politus*, *ambiguus*, and *teter* have this type of mandible. *D. ambiguus* differs from the other two in having a dorsal protuberance along the terebral margin of the left mandible, as in Type IIIb.

Left mandible smooth dorsally, declivous a short distance from and toward terebral margin, the latter 0.50 times the length of inner margin; retinacular ridge prominent, contacting posteriorly terebral margin, separated from it distally by a deep groove; base as in Type II with a well developed molariform process (figs. 84a and b). Right mandible as in Type III, except as noted above, terebral tooth well developed, terebral margin broadly and shallowly concave, 0.40 of total length of inner margin; retinacular ridge not prominent, space between it and terebral margin flat, not concave (figs. 84c and d).

### Fossil Species

*Dicaelus alutaceus* Horn, 1876: 244; Type locality: Bone Caves at Port Kennedy, Pennsylvania; (determined from original description).—Scudder, 1892: 524, Pl. I, figs. 8-10.

*Dicaelus* sp? Horn, ibid.—Scudder, ibid., p. 525, Pl. I, fig. 15.

Scudder figured the fragments representing these two forms. As only broken pieces of the elytra serve as the basis for the description of *D. alutaceus,* I do not feel that we can be at all sure that this species and the one that is undescribed belong to the genus *Dicaelus* or to any other ground beetle genus.

*Subgeneric Classification.—Dicaelus* was divided into two genera by Casey (1913: 154). He placed *D. laevipennis* LeC., and *D. flohri* Bates along with two new species in his new genus *Liodicaelus,* stating: " The generic name *Liodicaelus* may be suggested for those species now forming part of *Dicaelus* but differing from the others in having no trace of elytral striation, the elytra having, in the place of striae, unimpressed series of very small punctures. This imparts a decided difference in habitus, though at the same time there appears to be but few other structural differences of prominence, except the short antennae ". In addition to these characters, the internal sac of the male genitalia bears five or six spines, instead of three or four as in the other members of the genus. These are the only distinctive features of this group of species, and because of the general similarity between this group and the rest of *Dicaelus* with respect to habitus (Casey's opinion to the contrary not withstanding), mouth parts, and male and female genitalia, I do not see that the former characters should be given as much weight as Casey gave them. The species included in *Liodicaelus* are

not as different from the rest of *Dicaelus* as are the species of *Diplocheila* from the latter, and *Diplocheila* and *Dicaelus* are not very different from one another. So it seems to me to be a mistake in classification to treat *Liodicaelus* as generically distinct from *Dicaelus* unless we emphasize the differences between *Diplocheila* and *Dicaelus* by putting each in a separate higher category. Leng (1920: 62) reduced *Liodicaelus* to the status of subgenus and I agree with this action.

The species remaining in the typical subgenus (*sensu* Leng) seem to fall into two groups which are about as distinct from one another as either is from the members of *Liodicaelus*. To express this I propose the new subgenus *Paradicaelus* to include those species of *Dicaelus* in which the elytral striae are distinct and continuously impressed throughout, elytral intervals more or less convex, penultimate segment of the labial palpus bisetose, and the internal sac of the median lobe of the male genitalia bearing three or four spines. In addition, the mandibles, although of three different types, are unlike those of the typical subgenus as here defined.

Subgenus **Paradicaelus,** new subgenus

*Dicaelus* Bonelli (in part), 1813: 446.

GENOTYPE: *Dicaelus furvus* Dejean; (present designation).

The diagnostic features of *Paradicaelus* are indicated in the key and in the discussion of subgeneric classification.

The representatives of this group range from the coastal plain and piedmont of eastern United States westward to the Mississippi Basin, and to the eastern slopes of the Rocky Mountains, possibly *via* the forested regions of southern Canada, but do not occur west of the 100th meridian in the Plains States.

*Key to the Species of Subgenus Paradicaelus*

1. Right mandible with dorsal lateral margin bowed outward (fig. 84c) jutting out beyond lateral marginal plane of ventral margin ..... 2
   Right mandible with dorsal lateral margin normal, not bowed outward, its lateral marginal plane coinciding with that of ventral margin (fig. 83c) ..... 4
2. Elytral interval 7 not carinate, sides of pronotum not reflexed (fig. 92), beaded for their entire length ..... *D. politus* Dej.
   Elytral interval 7 carinate in about basal 1/2 of elytra, sides of pronotum reflexed (figs. 93 and 94), usually not beaded for their entire length 3
3. Left mandible with a tubercle on dorsal surface in front of apex of labrum, ratio PN: W base/W apex 1.35-1.63 for males, 1.25-1.49 for females, pronotum and dorsal surface of head coarsely rugose, opaque *D. ambiguus* Laf.
   Left mandible lacking tubercle on dorsal surface, ratio PN: W base/W apex 1.10-1.28 for males, 1.06-1.18 for females, pronotum and dorsal surface of head shining, macrosculpture lines obsolescent or far apart, the surface at most rugulose ..... *D. teter* Bon.
4. Left mandible with a dorsal ridge or tubercle close to terebral margin in front of labrum, pronotum of most specimens with two setigerous punctures near each lateral margin ..... *D. furvus* Dej. (*s. lat.*)
   Left mandible without a dorsal ridge or tubercle, pronotum with two or more setigerous punctures near each lateral margin ..... 5
5. Elytral interval 7 carinate for about 2/3 of length of elytra, pronotum with three or more setigerous punctures near each lateral margin in most specimens ..... *D. elongatus* Bon.
   Interval 7 carinate for about 1/3 the length of elytra, pronotum with two setigerous punctures near each lateral margin in most specimens ... 6
6. Elytral striae distinctly punctate, intervals in most specimens with ocellate punctures, and striae frequently broken and crossing intervals *D. sculptilis* Say (*s. lat.*)
   Elytral striae not punctate, intervals normal, without ocellate punctures, striae not broken or crossing over intervals (excepting normal convergence of striae in apical 1/6, toward sutural angle) *D. dilatatus* Say (*s. lat.*)

## Classification of the Species of the Subgenus *Paradicaelus*

The species of this subgenus may be arranged in the following groups.

A. *elongatus* group.

Mandibles of Type Ia, pronotum usually with 3 or more setigerous punctures on each side (93% of individuals examined), interval 7 carinate for about 2/3 the length of elytra, apical portion of median lobe inclined toward left, or if straight then apex is approximately truncate, dorsal apical hook more prominent than in other species of this genus, restricted to left of median longitudinal plane of median lobe, apex of hook acute, decidedly narrower than apical portion of median lobe, dorsal apical plate of internal sac with apical portion broadly rounded, left side extending farther basally than right, ventral apical plate with an irregularly shaped prominence on left side, plane of apex of dorsal plate below apical plane of ventral plate.

Included species:

*Dicaelus elongatus* Bonelli

B. *politus* group.

Mandibles of Type IV, pronotum usually with 2 setigerous punctures near each lateral margin (no known exceptions), interval 7 carinate for about 1/2 the length of elytra or not at all, apical portion of median lobe straight, dorsal hook either apical or preapical in position, laminate or not, apex as broad as apical portion of median lobe or considerably narrower, crossing median longitudinal plane of median lobe, dorsal apical plate with apical margin as in *D. elongatus,* ventral apical plate without an apical prominence on left side.

Included species:

*Dicaelus politus* Dejean
*Dicaelus teter* Bonelli
*Dicaelus ambiguus* Laferté

C. *furvus* group.

Mandibles of Type III, pronotum usually with two setigerous punctures near each lateral margin (a few specimens of *D. dilatatus* and *D. sculptilis* with 3 or more), interval 7 carinate for 1/3 or 2/3 of total length of elytra, apical portion of median lobe straight, dorsal hook apical in position, its apex narrower than apical portion of median lobe, crossing median longitudinal plane of median lobe, dorsal apical plate of internal sac with apical margin approximately truncate, the right side extending farther basally than left side, plane of apex well below apical plane of ventral apical plate, ventral apical plate without an apical prominence on left side.

Included species:

*Dicaelus furvus furvus* Dejean
*Dicaelus furvus carinatus* Dejean
*Dicaelus dilatatus dilatatus* Say
*Dicaelus dilatatus sinuatus* new subspecies
*Dicaelus sculptilis sculptilis* Say
*Dicaelus sculptilis intricatus* Le Conte
*Dicaelus sculptilis upioides* new subspecies

Characters which have been given the greatest weight in arriving at this classification are the mandibles and the male genitalia. Other characters are of value in diagnosing species, but I do not believe they are of greater importance.

## *elongatus* group

The diagnostic features of this group are presented in the discussion of the classification of the species of the subgenus *Paradicaelus.*

A summary of the distribution of this species group is presented in conjunction with the following description.

**Dicaelus (Paradicaelus) elongatus** Bonelli

*Dicaelus elongatus* Bonelli, 1813: 448.

*Dicaelus simplex* Dejean, 1826: 389; [type specimen in Oberthür Coll. (fide Lindroth).] Type locality: "Amerique septentrionale"; (the specimen was sent to Dejean by Le Conte, and was presumably collected either in New Jersey or Georgia).—Le Conte, 1848: 430.—Ibid., 1853: 389.—Horn, 1880: 52.—Casey, 1920: 406.

*Dicaelus ambiguus* Le Conte not Laferté, 1841, 1848: 428; [a single specimen in the Le Conte collection bearing the label "var. ambiguus? Ferté Ala." is a member of *D. elongatus* Bon., and is presumably the specimen on which this record was based].—Ibid., 1853: 389.

*Dicaelus opacus* Le Conte not Laferté, 1841, 1848: 429; [one specimen from Alabama, collected by Haldeman].—Horn, 1880: 52.

*Dicaelus obscurus* Le Conte, 1848: 428; [type specimen a female, in the Le Conte Coll., MCZ no. 5716]. Type locality: "southern states"; (type specimen labelled with an orange disc).—Ibid., 1853: 389.

*Dicaelus debiliceps* Casey, Mem. Col., Vol. III, p. 151, 1913; **New synonymy;** [type specimen a female, in Casey Coll.]. Type locality: Buena Vista Spring, Franklin Co., Pa.—Ibid., 1920: 206.

*Dicaelus ashevillensis* Casey, ibid.; **New synonymy;** [type specimen a male, in Casey Coll.]. Type locality: Asheville, North Carolina; (determined from original description).

Specimens of this species which lack the extra pair of setae on the pronotum are liable to be confused with members of the typical subspecies of *Dicaelus furvus*. However, the two are readily differentiated on the mandibular characters, *D. elongatus* having a well developed terebral tooth on the left mandible and lacking a dorsal protuberance, and *D. furvus* lacking the terebral tooth on the left mandible but having a small protuberance on the dorsal surface close to the terebral margin (figs. 83a and 86a). Beyond its superficial similarity to *D. f. furvus*, *D. elongatus* is a very distinctive species within the genus *Dicaelus*.

*Variation.*—For the number of synonyms listed under this species, variation is, at most, slight and local or individual. Size variation for a series of twenty males and twenty females, chosen at random from localities scattered throughout the range of the species, is as follows: males, length 15.2-19.0 mm. (16.6 mm.), width 6.0-7.8 mm. (6.7 mm.); females, length 14.9-18.4 mm. (16.4 mm.), width 6.0-7.7 mm., (6.6 mm.). Variation in size seems to be clinal in nature, with specimens from the Gulf Coastal states averaging distinctly larger than specimens from farther north and specimens from peninsular Florida (see Ball, 1954: 313 and table 25 for details). The proportions of the terminal segments of the palpi vary slightly.

The pronotum (fig. 91) is either more or less strongly constricted posteriorly and the sides are, in a few specimens, more or less reflexed laterally. The number of setigerous punctures on each side of the pronotum varies from two to as many as four, with a distinct mode at two. Data on variation in this character are presented in table 20. Because the two sides of a single pronotum frequently do not have the same number of punctures, the sum total is used rather than the number of punctures on a single side. The surface of the pronotum varies from almost smooth to rugulose, the smoother specimens occurring generally in the northern part of the species range and the more rugose ones farther south. The disc is somewhat flatter than average in specimens from Hope, Arkansas.

The setigerous punctures on the 6th abdominal sternite vary in number from 4-6 (4.8) in the males, and from 6 to 8 (6.8) in the females.

The median lobe of the male genitalia is as in figs. 107a and b, but the apical portion exhibits considerable variation in shape, as follows:

left margin straight rather than concave, right margin strongly obtuse, the apex, therefore, broadly truncate and appearing shorter than in fig. 107b; as in fig. 107b, but apex more rounded; apex as in figure, but more strongly inclined toward left; apex less inclined to left (twenty specimens have been examined).

*Synonymical Notes.*—The synonymy of this species as presented in the Leng Catalogue is satisfactory, except that *simplex* and *debiliceps* should be reduced to synonyms of *Dicaelus elongatus.* Both are founded on characteristics such as size and slight differences in proportions which are neither great enough nor constant enough to have taxonomic value. I have examined a large series of specimens from Asheville, North Carolina, the type locality of *D. ashevillensis* Casey, and find that the characters associated with this name are features of only an individual, and not of the entire Asheville series. Various specimens from this one locality can be placed in typical *elongatus*, typical *ashevillensis*, or neither, depending upon whether the pronotum narrows anteriorly from before or behind the middle, this being the key character which separates these species. A second variable feature, less unequally elevated intervals of the elytra as opposed to more unequally elevated intervals as in *D. elongatus* and *simplex*, seems to vary at random and not in a geographical pattern. Therefore, *D. ashevillensis* should also be treated as a synonym of *D. elongatus.*

*Immature Stages.*—See Schaupp (1878: 43 and 44) for description of larva and pupa of this species, and data on life history.

*Distribution.*—This species ranges from southern Quebec to southern Florida in the east, to at least 4000′ elevation in the Smoky Mountains, westward into the Plains, northward to northern Iowa, westward probably no farther than the 100th Meridian, and southward to northeastern Texas. I have collected this species on dry hillsides in October in the vicinity of Ithaca, New York, and have found it in moist leaf litter in a swamp in the vicinity of Oneco, Manatee County, Florida.

Two hundred forty-seven males and two hundred eighty-six females collected in the following states and provinces have been examined.

Peripheral localities—New Hampshire: Sullivan County, Cornish. New York: King's County, Staten Island. Florida: Dade County, Paradise Key. Kansas: Douglas County, Lawrence. Michigan: Oakland County, Milford. Additional states—Alabama. Arkansas. Connecticut. District of Columbia. Georgia. Illinois. Indiana. Iowa. Kentucky. Louisiana. Maryland. Massachusetts. Mississippi. Missouri. Nebraska. New Jersey. North Carolina. Ohio. Oklahoma. Pennsylvania. Rhode Island. South Carolina. Tennessee. Texas.

TABLE 20

*Dicaelus elongatus:* Variation in Total No. of Marginal Setigerous Punctures on Pronotum.

| | Males | | Females | |
|---|---|---|---|---|
| Number of Punctures | Number of Specimens | % of Total Number of Specimens | Number of Specimens | % of Total Number of Specimens |
| 4 | 3 | 1.10 | 2 | 0.80 |
| 5 | 10 | 3.68 | 3 | 1.30 |
| 6 | 224 | 82.35 | 194 | 83.30 |
| 7 | 28 | 10.30 | 27 | 11.60 |
| 8 | 7 | 2.57 | 7 | 3.00 |

*politus* group

One element of this group consists of the species *politus* which differs from the other two species in its smaller size, possession of a somewhat elongate pronotum with narrow lateral grooves and margins completely beaded, the lack of carination of elytral interval 7, even at base, and a kind of median lobe which is unique in the genus. The remaining two species, *ambiguus* and *teter*, although differing in some minor characters and readily distinguished from one another by them, are fundamentally very similar morphologically.

The members of this group are restricted in their distribution to North America east of the 100th Meridian, ranging northward to southern Quebec, southward to northern Florida in the east, and to extreme southeastern Texas farther west; in altitude, from near sea level to at least 5300 feet elevation, in the Smoky Mountains.

Size variation in these three species is geographical, with larger specimens occurring to the south, or at lower elevations, and smaller specimens occurring farther north, or at higher elevations. However, no correlative characters have been found so each member of this group

is treated here as being monotypic. The fact that no apparent differences exist between samples collected on the east and west sides of the Appalachians suggests that there is gene flow across the mountains, or that the populations occurring on either side of the mountains have been isolated longitudinally for a relatively short period of time, or that evolution proceeds at a very low rate, relative to the rates in other species of the genus.

**Dicaelus (Paradicaelus) politus** Dejean

*Dicaelus politus* Dejean, 1826: 391; [type specimen in Oberthür Coll. (fide Lindroth.)]. Type locality: "Amerique septentrionale"; (determined from original description; specimen received from Le Conte, and may have been collected either in New Jersey, or Georgia).—Le Conte, 1848: 431.

*Dicaelus leonardi* Harris, New England Farmer, 1828; [type specimen in Harris Coll., Museum of Comparative Zoology, Harvard University].—Le Conte, 1848: 431.

*Dicaelus angustus* Casey, 1913: 152; **New synonymy;** [type specimen a female, in Casey Coll., USNM no. 47363]. Type locality: Tennessee; (determined from original description).—Leng, 1920: 62.

The smallest species of the genus, *Dicaelus politus*, may be readily separated from its congeners by the characters given in the keys.

*Variation.*—The size varies, possibly clinally, with larger specimens coming from southern localities and smaller specimens, on the average, coming from more northern places (see Ball 1954: 313, table 24). See table 21 for a summary of data on variation in maximum width for twenty males and twenty females chosen from localities scattered throughout the range of the species. See also tables 22 and 23 for data on variation in the ratios PN : W/L and PN : W base/W apex, for the same specimens.

The macrosculpture of the pronotum varies only in degree of development with no geographical pattern apparent. In one female from Crawford County, Indiana (Purdue University, Blatchley Coll.), the posterior lateral impressions extend cephalad as broad shallow troughs almost to the discal pits, and the shallow, transverse lines extend forward to contact the pits. These pits are sporadic in their occurrence and are apparently not correlated with geographical distribution. Shape of the pronotum (fig. 92) varies from more elongate to less elongate and more quadrangular, the lateral margins from almost

straight to moderately arcuate, the posterior-lateral sinuation from more to less distinct. Generally the pronotum appears to be more quadrate in the larger specimens, but this is not an invariable relationship and is not supported by actual measurements. Convexity of the disc exhibits slight variation. The lateral margins of the pronotum exhibit complete beading in thirty-eight of forty specimens examined for this character. In the remaining two specimens the sides are beaded for about three fourths of their length.

The sculpture of the abdominal sternites varies slightly in degree. The number of setigerous punctures on the 6th abdominal sternite in twenty males and twenty females is: males, 2-3 (2.2); females, 5-8, (6.1). No variation was noted in the structure or shape of the male genitalia (figs. 108a and b).

*Synonymical Notes.*—Le Conte (1848) placed *D. leonardi* Harris in the synonymy of *politus* Dejean. I have seen Harris' type and concur with Le Conte's opinion regarding its status. Leng (1920) reduced Casey's *D. angustus* to a variety of *politus* Dejean, but the characters which separate the two are of such a slight and variable nature that I see no reason for dividing this species. Size is the main diagnostic feature, and this seems to vary clinally. The other features, such as more quadrate pronotum, are not sufficiently constant. For example, a series of five larger than average specimens from northern Alabama show variation from an essentially quadrate to a more typical pronotum. Otherwise these specimens resemble closely a specimen from Chattanooga, Tenn., thus topotypical of *angustus*.

*Notes on Immature Stages.*—The only published information concerning the larva and pupa of this species has been presented by Schaupp (1878: 44).

*Distribution.*—This species is known from localities throughout the Appalachian region, southward to northern Alabama and Georgia, eastward on the Piedmont in the southern states, northward to Quebec, and westward to northern Iowa and possibly to the 100th Meridian. Horn (1880: 52) records this species from "Fla.". Leng, (1915: 380) quotes Horn's record but gives no other. I have not seen any specimens from this state, and if the species occurs here it is probably to be found only in the northernmost counties, probably in the vicinity of the Appalachicola River.

I have found this species under the bark of dead trees, under rocks and pieces of wood on the ground in oak-beech and beech-hemlock forests in the vicinity of Ithaca, New York, and in a beech-hemlock forest in Lawrence County, Alabama.

I have examined one hundred twenty-seven males and ninety-five females, collected in the following states.

Peripheral localities—New Hampshire: Crafton County, Franconia. Alabama: Madison County, Monte Sano. Iowa: Clayton County. Wisconsin. Additional states—Connecticut. District of Columbia. Georgia. Illinois. Indiana. Kentucky. Maryland. Massachusetts. Michigan. New Jersey. New York. North Carolina. Ohio. Pennsylvania. Tennessee. Virginia.

**Dicaelus (Paradicaelus) ambiguus** Laferté

*Dicaelus ambiguus* Dejean, 1837: 31; [nomen nudum].
*Dicaelus ambiguus* Laferté, 1841: 44.—Ibid., 1851: 277.—Le Conte, 1873: 324.
*Dicaelus opacus* Laferté, 1841: 43; Type locality: "Texas"; (determined from original description).—Le Conte, 1873: 324.—Löding, 1945: 18.
*Dicaelus reflexus* Le Conte, 1848: 330; [type specimen a male, in Le Conte Coll., MCZ no. 5717]. Type locality: Columbia, Pennsylvania; (determined from original description).—Ibid., 1873: 324.
*Dicaelus turbulentus* Le Conte, 1863: 12; [type specimen a female, in Le Conte Coll., MCZ no. 5718]. Type locality: Missouri; (collected by Prof. Agassiz; determined from original description).—Horn, 1880: 52.

This species most closely resembles *D. teter* but may be distinguished from it by the following characters as well as by those which are presented in the key: lateral margins of pronotum more strongly reflexed, not strongly sinuate posteriorly and surface of head and pronotum rugulose to moderately rugose.

*Variation.*—Size variation was not studied in detail because of the paucity of available material. Data on variation in width and in the ratios PN: W/L, and W base/W apex of a series of twenty males and twenty females, chosen from localities scattered throughout the range of this species, are presented in tables 21, 22, and 23. The latter ratio is useful in separating this species from *D. teter*.

Lustre of the integument varies from opaque to somewhat shining, but never as shining as is average for *D. teter*, and the variation seems to be of an individual, rather than of a population, nature. Shape of the pronotum and degree of upturning of the sides varies slightly.

Smaller specimens tend to have the pronotum more strongly flanged than larger specimens. Of forty specimens examined, thirty completely lack the lateral beading on the pronotum; in five specimens the bead is about 1/4 of the total length of the pronotum, and in the five the beading extends for about 1/2 the length of the pronotum. The length of the carinate portion of interval 7 varies from an average of about 1/3 of the total length of the elytra, to about 1/2 in a specimen collected at South West, Arkansas (Amer. Mus. Nat. Hist. Coll.). The median lobe (fig. 109) exhibits slight variation in shape of the apical portion.

One specimen, a male collected at Bard Springs Camp, Ouachita Mountains, Polk County, Arkansas, August 15, 1951, by T. J. Cohn, is quite different from all of the other specimens which I have referred to this species. The pronotum is cordate in shape, resembling, to some extent, *D. teter*. The carina of the 7th interval extends for 2/3 of the total length of the elytra and the elytra are flatter than usual. It is thus quite different in appearance from the average run of this species. However, the dorsal surface of the left mandible bears the usual tubercle and the genitalia are typical for *D. ambiguus*. The following irregularities of the pronotum suggest that this specimen may have had an abnormal development: right anterior margin with a noticeable undulation, median longitudinal impression bent slightly to left before midline.

*Synonymical Notes.*—Le Conte (1873) established the synonymy presented above and used *ambiguus* as the name for this species, even though *opacus* Laferté was the senior synonym. Since his study was, in essence, a revision of the species, Le Conte may be regarded as first reviser and as such had the privilege of choosing which name he pleased (see Article 28, Rules of Zoological Nomenclature, 1905). Therefore, the name *ambiguus* stands as the correct trivial name for this species.

The type specimen of *turbulentus* is a normal representative of *ambiguus* as Horn (1880) indicated.

*Distribution.*—This species ranges on the piedmont and coastal plain of eastern United States from northern Florida possibly to central New York, extending westward of the Appalachians across Pennsylvania to southeastern Iowa; eastward along the coastal plain and piedmont to southeastern Texas, and in the eastern states of the Great Plains. Presumably it will be found southward in the temperate por-

tion of northern Mexico, westward probably to the 100th Meridian, and northward to, but probably not much beyond, the southern limits of the Transition Zone forest.

I have collected this species in a beech-hemlock forest in Lawrence County, Alabama, in a mixed mesophytic forest in Tuscaloosa County, Alabama, in a moist situation.

I have examined sixty-two males and fifty-five females collected in the following states.

Peripheral localities—PENNSYLVANIA: Monroe County, Water Gap. DISTRICT OF COLUMBIA. FLORIDA: Liberty County, Camp Torreya. TEXAS: Cameron County, Brownsville. IOWA: Lee County. INDIANA: Tippecanoe County, Lafayette. Additional states—ALABAMA. ARKANSAS. GEORGIA. ILLINOIS. KENTUCKY. MISSOURI. NORTH CAROLINA. OHIO. TENNESSEE.

**Dicaelus (Paradicaelus) teter** Bonelli

*Dicaelus teter* Bonelli, 1813: 449. Type locality: "Amerique septentrionale"; (determined from original description).—Le Conte, 1848: 431.

*Dicaelus ovipennis* Casey, 1913: 152; [type specimen a male, in Casey Coll., USNM no. 47362]. Type locality: North Carolina; (determined from original description).—Leng, 1920: 62.

A combination of relatively narrow pronotal base, sides of pronotum reflexed, and sinuate posteriorly (fig. 93), surface of integument generally smooth and shining, and the mandibles peculiar to the *politus* group separate this species from all others of the genus.

*Variation.*—There is distinct, and probably geographical, size variation. A series of twenty males chosen at random throughout the range of the species vary in length from 16.2-19.2 mm. (mean 17.8 mm.), twenty females vary from 14.9-21.2 mm. (mean 18.1 mm.). For a summary of data on variation in maximum width for this species, see table 21. For the ratios PN : W/L, and PN : W base/W apex, see tables 22 and 23.

Surface sculpture varies, and all extremes can be found within the series of specimens collected in the state of New York. The proportions of the terminal palpal segments vary slightly but seemingly at random. The lateral margins of the pronotum vary posteriorly from strongly sinuate to weakly straight, and anteriorly from strongly arcuate to almost straight, but again in no geographical pattern. The posterior lateral sinuation is lacking in three specimens collected at Monte Sano, Walker County, Alabama, and these specimens are large

in size: two males, 20.0 and 21.2 mm.; one female, 21.4 mm. These specimens may be sufficiently different to warrant their inclusion in a separate subspecies but their status cannot be determined on the basis of so few specimens. In thirty of forty specimens examined there was no evidence of beading; in eight specimens the bead extends for about 1/2 the length of the lateral margins, and for 1/4 and 3/4 of the length of the lateral margins in two specimens. The 6th abdominal sternite has a variable number of setigerous punctures: for 20 males, 4-6 (4.5); for 20 females, 5-11 (7.4). The male genitalia do not exhibit any significant variation, and are like those of *ambiguus*.

*Synonymical Notes.*—Casey's species, *D. ovipennis*, is based on a smaller than average specimen of *D. teter*. The small parallel-sided pronotum may be simply the result of general small size, and the seeming inflation of the elytra is probably the result of the more than average narrowing of the elytra at base. Reticulation of the elytra is a variable character and is not of much use as a diagnostic character in this species. Variation in the length of segments of the maxillary palpi is insignificant, and I therefore relegate the name *Dicaelus ovipennis*, which is based on the above characters, to the synonymy of *D. teter*.

*Distribution.*—This species ranges through the Appalachian region of eastern United States southward to northern Alabama, westward to southwestern Indiana, northward to southern Canada, and eastward to the Atlantic. In altitude, this species ranges from at or near sea level, to at least 5000′ in the Smoky Mountains.

I have taken this species in a variety of localities in New York State and in southwestern Pennsylvania, always under cover in moist, forested areas.

I have examined one hundred seventy-six males and one hundred forty-six females collected in the following states.

Peripheral localities—ONTARIO: Brant County, Hamilton. CONNECTICUT: Litchfield County, Cornwall. ALABAMA: Madison County, Monte Sano. MICHIGAN: Washtenaw County. Additional states—DISTRICT OF COLUMBIA. GEORGIA. KENTUCKY. MARYLAND. NEW JERSEY. NEW YORK. NORTH CAROLINA. OHIO. PENNSYLVANIA. TENNESSEE. VIRGINIA. WEST VIRGINIA.

TABLE 21

*Dicaelus politus* group: Variation in Maximum Width (mm.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *politus* ..... | 20 | 4.6– 6.0 | 5.1 | 20 | 4.3– 5.7 | 5.0 |
| *ambiguus* ..... | 20 | 7.2–10.0 | 8.6 | 20 | 8.2–10.7 | 9.2 |
| *teter* ..... | 20 | 5.6– 8.2 | 7.3 | 20 | 6.4– 8.9 | 7.7 |

TABLE 22

*Dicaelus politus* group: Variation in Ratio PN: W/L.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *politus* | 20 | 1.15–1.35 | 1.23 | 20 | 1.17–1.32 | 1.23 |
| *ambiguus* ..... | 20 | 1.34–1.50 | 1.42 | 20 | 1.32–1.53 | 1.42 |
| *teter* ..... | 20 | 1.30–1.49 | 1.40 | 20 | 1.28–1.60 | 1.44 |

TABLE 23

*Dicaelus politus* group: Variation in Ratio PN: W base/W apex.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *politus* ..... | 20 | 1.21–1.63 | 1.40 | 20 | 1.26–1.42 | 1.35 |
| *ambiguus* ..... | 20 | 1.35–1.63 | 1.48 | 20 | 1.25–1.49 | 1.38 |
| *teter* ..... | 20 | 1.10–1.28 | 1.20 | 20 | 1.06–1.18 | 1.13 |

*furvus* group

The three species included in this group are not equally differentiated from one another. The type species of this subgenus, *furvus*, stands by itself on the basis of the tubercle on the left mandible, average smaller size, proportionately average narrower elytra, and elytral carina extending about 2/3 the total length of the elytra. *D. sculptilis* and *dilatatus* are, on the average, large and proportionately broader species, lacking a tubercle on the left mandible, and the elytral carina extends for only about 1/3 the total length of the elytra. The morphological gap between *dilatatus* and *sculptilis* is practically bridged by a series of specimens from Tennessee (see discussion of variation under *sculptilis*).

The members of this group range throughout the United States east of the 100th Meridian, entering southern Canada in south-central Ontario (Pelee Island), and in the southern portion of the Prairie Provinces, southward to Gainesville, Florida; to an elevation of about 4000′ at Asheville, North Carolina. Further to the west, this species group is represented by *Dicaelus sculptilis* on the eastern slopes of the Rocky Mountains, at an elevation of about 5000′ in Colorado and about 7000′ at Jemez Springs, New Mexico.

Geographical variation in size and in rugosity of the integument occurs in these three species, larger and more rugose individuals being found, on the average, to the south, and smaller and smoother specimens occurring northward. The fact that a certain amount of differentiation exists between samples of *dilatatus* and *furvus* from the east as opposed to the west side of the Appalachians, and that samples with intermediate characters are known from intermediate localities at low elevations, suggests that gene flow is around, rather than across, the mountains.

**Dicaelus (Paradicaelus) furvus** Dejean

This species is likely to be confused only with specimens of *Dicaelus elongatus* that have fewer than three setigerous punctures on each side of the pronotum. (See distinguishing features of *elongatus* for detail). In *elongatus* the discal intervals of the elytra are all of about the same width, but in *f. carinatus* 3 and 5 are usually wider than the remaining discal intervals.

Restricted to the United States east of the Rocky Mountains and probably west of the 100th Meridian, *Dicaelus furvus* ranges on the

coastal plain and piedmont of the east coast from at least central Pennsylvania and New Jersey southward to northern Florida; westward on the Gulf Coast at least to Louisiana (probably also eastern Texas), and north in the Mississippi Valley to eastern Kansas and Nebraska; thence eastward through Illinois, Indiana, and Ohio.

The diagnosis presented in the key covers three named forms: *furvus* Dejean, *carinatus* Dejean, and *ovalis* Le Conte. These have been characterized by their authors, or other students of the genus *Dicaelus*, as follows: *furvus*—size smaller, carina formed by interval 7 of the elytra lower, and elytral intervals on the disc only moderately alternating in width (3 and 5 slightly but distinctly wider than 1, 2, 4, and 6); *carinatus*—size larger, carina formed by interval 7 more strongly developed, and elytral intervals 3 and 5 considerably wider than 1, 2, 4, and 6; *ovalis*—size smaller, pronotum more broadly rounded laterally, elytral carina as in *carinatus*, and intervals 3 and 5 as wide as 1, 2, 4, and 6, but not wider. An additional character, mentioned only by Le Conte in the original description of *ovalis*, is the rugosity of the head and pronotum. Specimens referable to *carinatus* on the basis of the above characterization have the dorsal surface of the head and pronotum strongly rugose, while specimens referable to *furvus* and *ovalis* have these same areas varying from smoother and more shining than in *carinatus* to almost completely smooth.

As the supposedly diagnostic characters of the forms mentioned above are only portions of a morphological continuum, I regard these three as representatives of the same species and not as distinct species. The apparent relative height of the elytral carina seems to be a direct correlative of size, i.e. larger specimens have the carina *apparently*, but not really, more strongly developed simply because of the general increased body size. The pronotal character given for *ovalis* seems to be individually variable, whereas the remaining characters seem to vary geographically.

*Geographical Variation.*—All of the specimens available were arranged in a series of nine samples, as follows: " E. Pa.", Pennsylvania, from the environs of the Susquehanna River Valley and eastward; " Md.-Va." Maryland, District of Columbia, West Virginia, and Virginia: " W. Pa.", Allegheny County, Pennsylvania; " O.-Ill.", Ohio, Indiana, Illinois; " Mo.-Ark.", eastern Kansas, Missouri, and Arkan-

sas; " Ia.", Iowa; " Tenn.", Chattanooga, and westward in Tennessee; " N. C.", North Carolina; " Ala.-Miss.", Alabama and Mississippi, piedmont and coastal plain.

Relative rugosity of the dorsal surface of the head and pronotum is, in general, less pronounced in specimens from the north and east, distinctly coarser and more distinct in specimens from the north and west, and most pronounced in specimens from Alabama and Mississippi. Lustre of the integument is correlated with rugosity: the coarser the rugosity, the more opaque the integument.

Size is expressed here in terms of total length (table 24). The more northern samples are composed of individuals which on the average are smaller than are the components of the more southern samples. Failure to form a neat cline, i.e. with the geographically most widely separated samples also morphologically most widely separated, may be due, at least in part, to sampling error which is probably large.

To express the character involving degree of alternation of width of the elytral intervals numerically, the width of interval 5 and interval 4 was measured for each specimen at a point on the left elytron slightly below the apex of the scutellum. Then the width of interval 5 was divided by the value obtained for the width of interval 4 to yield a single numerical value. These data are summarized in table 25. The most salient feature emerging from a statistical analysis of these data was that the differences between the E. Pa. and Ala.-Miss. samples were statistically significant, and that these samples could be regarded as being subspecifically distinct. (For details see Ball, 1954: tables 31-34). Assuming the E. Pa. and Ala.-Miss. samples represented approximately topotypical populations of *furvus* and *carinatus*, these samples were used for arriving at a hybrid index by utilizing the following method. Typical specimens of *furvus* received a value of 2, typical specimens of *carinatus* a value of 6. " Typical " was defined in this way: a specimen falling within $1^{+}$ S. D. of the mean of the E. Pa. sample for one character was regarded as " typical " for that character and assigned a value of 1. If a specimen fell within $1^{+}$ S. D. of the mean for both characters, this individual received a value of 1 for each character, and the sum of these yielded the hybrid index value of 2. On the other hand, a specimen falling within $1^{-}$ S. D. of the mean of the Ala.-Miss. sample received a value of 3 for each character within this

range, and a hybrid index value of 6. Specimens intermediate for one or both characters received intermediate values. The basis for determining the hybrid index values is presented in table 26.

**Dicaelus furvus furvus** Dejean

*Dicaelus furvus* Dejean, 1826: 388; [type specimen in Oberthür Coll. (fide Lindroth.)]. Type locality: "Amerique Septentrionale"; (type specimen sent to Dejean by Thos. Say);—Le Conte, 1853: 389.

*Dicaelus ovalis* Le Conte, 1848: 327; **New synonymy**; [specimen labelled as type a female in Le Conte Coll., MCZ no. 5715]; Type locality: none indicated in original description; (specimen labelled as type, labelled with an orange disc—"southern states").—Ibid., 1853: 389.

**Dicaelus furvus × carinatus**

*Dicaelus furvus* Blatchley (not Dejean), 1910: 115.

*Dicaelus ovalis* Blatchley (not Le Conte), ibid., p. 116.—Brimley, 1938: 122.

Typical members of this subspecies exhibit the following combination of characters: Males, length 15.4 mm. or less, ratio width elytral interval 5/W E1 int. 4, 1.13 or less; females, length 15.1 mm. or less, W E1 int. 5/W E1 int. 4, 1.18 or less; pronotum and dorsal surface of head rugulose, the lines of macrosculpture relatively fine and relatively far apart, integument almost smooth, shining. Specimens of this species from Pennsylvania and localities south and east of the Appalachians at least as far south as northern Virginia and Washington, D. C. may be included in the typical subspecies.

*Variation.*—A summary of data on variation in total length is presented in table 24 and of values for the ratio W El int. 5/W El int. 4 in table 25 (E. Pa., D.C.-Md. and W. Pa. samples). Lateral margins of the pronotum vary slightly in roundness and the anterior margin varies slightly in width. Variation in extent of lateral beading of the pronotum for a composite sample of eight specimens of both subspecies and intermediates is as follows: complete—2 specimens; about 3/4 length of lateral margin—14; about 1/2—52; about 1/4—1; beading completely absent—8. Width in a composite sample of *D. f. furvus* varies as follows: 20 males, 5.8-7.0 mm. (6.3 mm.); 20 females, 5.9-7.1 mm. (6.6 mm.). Number of setae near the apical margin of the 6th abdominal sternite varies as follows: 20 males, 2-5 (3.4); 20 females 6-10 (7.4).

*Synonymical Notes.*—The type series of *Dicaelus ovalis* Le Conte consists of five specimens. The type specimen, a female collected in the southern states, is slightly less than 22.0 mm. in length, has a value of 1.17 for the ratio W El int. 5/W El int. 4, and the dorsal surface of the head and pronotum is rugose. The remaining specimens were collected in the " middle states ", and have the dorsal surface of the head and pronotum rugulose; the ratio W El int. 5/W El int. 4 has the following values: " *ovalis* 2 "—1.31; " *ovalis* 3 "—1.12; " *ovalis* 4 "—0.96; " *ovalis* 5 "—1.12. " *ovalis* 2, 3, and 4 " are females, " *ovalis* 5 " is a male. I neglected to obtain the lengths of these specimens.

I do not believe that the specimen described by Le Conte is the one now labelled as type. The original description calls for a female 0.62 in. in length (15.5 mm.), with head rugose, and pronotum transversely lightly rugose. Subsequently Le Conte gave additional characteristics of *ovalis* by stating that: " its form is a little broader, the interstices of the elytra are all equal, and the 8th [7th?] is more acutely elevated, (1853: 388). The combination of the elytral interval character (interstices) with the diagnostic features given in the original description would seem to indicate that Le Conte's concept of *ovalis* was not based on the specimen which at present bears the type label. Therefore, one of the other specimens in the series is really the type, although the elytral intervals in none of them are all of the same width. If this is true, then the type locality of *ovalis* must be in the " middle states ". As the type locality of *D. furvus* as restricted by me is eastern Pennsylvania, and as Pennsylvania is included in Le Conte's definition of the " middle states ", then it follows, or at least seems reasonable if what was said above is true, that *ovalis* is a synonym of *furvus* Dejean.

*Type locality.*—The exact type locality of *Dicaelus f. furvus* is not and cannot be known with certainty. However, Lindroth (*in litt.*) has informed me that the type is very much like a specimen from eastern Pennsylvania. As the type of *furvus* was sent to Dejean by Say, and as Say lived for a time in eastern Pennsylvania and could have collected the specimen there, I have restricted the type locality to that state, east of the Susquehanna River.

*Distribution.*—This subspecies ranges from Pennsylvania southward on the piedmont and coastal plain, at least to the latitude of Washington, D. C. Specimens from North Carolina, Tennessee, Ohio, In-

diana, and Illinois are regarded as intergrades between *D. f. furvus* and *D. f. carinatus.*

Notman (in Leonard, 1926:219) records *Dicaelus ovalis* from Buffalo, and from McLean Bogs (Tompkins Co.), New York. I have not been able to verify these records.

I have seen twenty-seven males and thirty-eight females collected in the following localities.

District of Columbia: Washington; Woodridge. Maryland: Harford County; Edgewood. Washington County; Hagerstown. Pennsylvania: "Pa." Allegheny County; Allegheny, Pittsburgh. Centre County; State College, Shingleton. Cumberland County; Camphill, Enola, Le Mogne, Cumberland. Dauphin County; Rockville. Delaware County; Castle Rock. Lancaster County; Lancaster. Lehigh County; Allentown. Northampton County; Easton, Wind Gap. Philadelphia County; Lawndale, Philadelphia. County not determined, Heckton Mills. Virginia: Amherst County; Sweet Briar. County not determined; Difficult Run. West Virginia: "W. Va."

Fourteen males and twenty females collected in the following localities are regarded as intergrades between *f. furvus* and *f. carinatus.*

Illinois: "Ill." "Champaign County; Urbana. "Lawrence County." Indiana: "Ind." "Crawford County." "Dearborn County." "Gibson County." "Koscuisko County." "Posey County." "Putnam County." "Vigo County." North Carolina: "N.C." Buncombe County; Asheville. Tennessee: Cumberland County; Grassy Cove. Fentress County; Allardt. Hamilton County; Chattanooga. Obion County; Obion. Wilson County; Cedars of Lebanon St. Pk. Ohio: "Ohio."

**Dicaelus furvus carinatus** Dejean, new combination

*Dicaelus carinatus* Dejean, 1831:689. Type locality: "Amerique septentrionale"; (determined from original description).
*Dicaelus furvus* Löding (not Dejean), 1945:18.—Fattig, 1949:31.
*Dicaelus ovalis* Fattig (not Le Conte), ibid.

Typical members of *Dicaelus f. carinatus* may be recognized by the following combination of characters: Males, length 16.6 mm. or more, females, length 16.5 mm. or more, elytral ratio with values of 1.22 or greater. Further, specimens of this subspecies have the integuments more rugose and more opaque than have typical members of *D. f. furvus.*

*Variation.*—For a summary of data on variation in length, see table 24; and table 25 for a summary of data on variation in W El int. 5/W El int. 4 (Ia.-Neb., Mo.-Ark., and Ala.-Miss.). Width in a

composite sample of this subspecies varies as follows: 20 males, 6.2-8.1 mm. (7.2 mm.); 20 females, 6.3-8.1 mm. (7.7 mm.). Sculpture of the dorsal surface of the head and pronotum is never as weakly developed as in typical specimens of the typical subspecies. Lateral margins of the pronotum vary as in *D. f. furvus*, tending, however, to be less arcuate in the southeastern states and somewhat more so in the plains states. Variation in the number of setae on the 6th abdominal sternite is as follows: 20 males, 3-5 (4.0); 20 females, 5-9, (7.0). The shape of the apical portion of the median lobe varies slightly.

*Type locality.*—The type specimen was sent to Dejean by Le Conte and was probably collected in Georgia, on or near the coastal plain. Dejean's description fits specimens from the Gulf states, and as authors subsequent to Dejean have regarded this species as a resident of the South, I here restrict the type locality to the coastal plain of Georgia.

*Distribution.*—The geographical range of this subspecies includes at least the Gulf States, excluding the peninsular portion of Florida, and the plains states east of the 100th Meridian, northward at least to southern Iowa. Probably this subspecies ranges farther north on the eastern coast, but the lack of specimens from Georgia northward to and including Virginia makes it impossible to determine its northern limits.

I have found several specimens of *Dicaelus f. carinatus* under cover in the open, river-bottom woods in the vicinity of Tuscaloosa, Alabama.

Twenty-seven males and twenty-six females of this subspecies have been examined.

ALABAMA: Chambers County; Langdale. Etowah County; Gallant. "Jefferson County." "Madison County;" Monte Sano. Mobile County; Calvert, Mobile, Mt. Vernon, Spring Hill. St. Clair County; Blount Mts. Tuscaloosa County; Tuscaloosa. County not determined; Tumblin Gap. ARKANSAS: "Ark". GEORGIA: Fulton County; Atlanta. IOWA: "Ia". "Appanoose County". "Davis County". Henry County; Mt. Pleasant. Iowa County; S. Amana. Johnson County; Iowa City. "Louisa County". "Monroe County"; Albia. "Muscatine County". "Page County". KANSAS: "Kan". "Douglas County"; Lawrence. "Franklin County". Wilson County; Benedict. County not determined; Centre Lakes. MISSISSIPPI: Carrol County; Avalon. George County; Lucedale. Greene County; Leakesville. Grenada County; Dubard Sta., Youngs. MISSOURI: Mississippi County; East Prairie. "St. Louis".

TABLE 24

*Dicaelus furvus:* Variation in Total Length (mm.).

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| E. Pa. | 19 | 13.8–15.9 | 14.9 ± 0.13 | 0.57 ± 0.09 | 3.8 |
| Md.-Va. | 3 | 15.1–16.3 | 15.7 | | |
| N. C. | 2 | 15.1–15.6 | 15.4 | | |
| Tenn. | 1 | 16.7 | | | |
| W. Pa. | 2 | 16.5–16.6 | 16.55 | | |
| O.-Ill. | 11 | 14.4–16.9 | 15.8 ± 0.48 | 1.60 ± 0.34 | 10.1 |
| Ia.-Neb. | 5 | 15.7–16.6 | 16.2 | | |
| Mo.-Ark. | 13 | 16.0–17.3 | 16.7 ± 0.13 | 0.49 ± 0.10 | 2.9 |
| Ala.-Miss. | 9 | 16.4–18.7 | 17.4 ± 0.31 | 0.94 ± 0.22 | 5.4 |
| | | Females | | | |
| E. Pa. | 18 | 13.7–15.6 | 14.7 ± 0.11 | 0.45 ± 0.08 | 3.1 |
| D. C.-Va. | 7 | 14.6–16.9 | 15.7 | | |
| N. C. | 2 | 15.2–16.0 | 15.6 | | |
| Tenn. | 6 | 15.7–17.9 | 17.0 | | |
| W. Pa. | 5 | 14.4–16.4 | 15.4 | | |
| O.-Ill. | 12 | 14.5–18.0 | 15.8 ± 0.32 | 1.11 ± 0.22 | 7.0 |
| Ia.-Neb. | 9 | 14.6–16.2 | 15.4 ± 0.20 | 0.60 ± 0.14 | 3.8 |
| Mo.-Ark. | 10 | 16.5–18.5 | 17.2 ± 0.22 | 0.71 ± 0.16 | 4.1 |
| Ala.-Miss. | 8 | 15.3–18.8 | 16.8 ± 0.46 | 1.31 ± 0.33 | 7.8 |

TABLE 25

*Dicaelus furvus:* Variation in Ratio W El int. 5/W El int. 4.

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| E. Pa. | 19 | 1.00–1.20 | 1.06 ± 0.02 | 0.07 ± 0.01 | 6.6 |
| Md.-Va. | 3 | 1.00–1.12 | 1.06 | | |
| N. C. | 2 | 1.13 | 1.13 | | |
| Tenn. | 1 | 1.00 | | | |
| W. Pa. | 2 | 1.06–1.12 | 1.09 | | |
| O.-Ill. | 11 | 1.00–1.47 | 1.23 ± 0.05 | 0.17 ± 0.04 | 13.8 |
| Ia.-Neb. | 5 | 1.17–1.47 | 1.31 | | |
| Mo.-Ark. | 13 | 1.06–1.53 | 1.31 ± 0.05 | 0.17 ± 0.03 | 13.0 |
| Ala.-Miss. | 9 | 1.16–1.50 | 1.30 ± 0.04 | 0.11 ± 0.03 | 8.5 |
| | | Females | | | |
| E. Pa. | 18 | 1.00–1.45 | 1.11 ± 0.02 | 0.10 ± 0.02 | 10.0 |
| Md.-Va. | 7 | 1.06–1.12 | 1.10 | | |
| N. C. | 2 | 1.06 | 1.06 | | |
| Tenn. | 6 | 1.00–1.11 | 1.06 | | |
| W. Pa. | 5 | 1.06–1.20 | 1.11 | | |
| O.-Ill. | 12 | 1.05–1.57 | 1.34 ± 0.05 | 0.17 ± 0.03 | 12.7 |
| Ia.-Neb. | 9 | 1.22–1.70 | 1.43 ± 0.05 | 0.16 ± 0.04 | 11.2 |
| Mo.-Ark. | 10 | 1.10–1.53 | 1.26 ± 0.04 | 0.16 ± 0.03 | 11.1 |
| Ala.-Miss. | 8 | 1.16–1.47 | 1.30 ± 0.04 | 0.11 ± 0.03 | 8.5 |

TABLE 26

SUMMARY OF BASIS FOR ASSIGNMENT OF HYBRID INDEX VALUES.

Males

Length

| Subspecies | Range | Value |
|---|---|---|
| typical *furvus* ..... | 15.4 mm., or less | 1 |
| intergrade ..... | 15.5–16.5 mm. | 2 |
| typical *carinatus* ..... | 16.6 mm., or more | 3 |

W El int. 5/W El int. 4

| Subspecies | Range | Value |
|---|---|---|
| typical *furvus* ..... | 1.13, or less | 1 |
| intergrade ..... | 1.14–1.18 | 2 |
| typical *carinatus* ..... | 1.19, or more | 3 |

Females

Length

| Subspecies | Range | Value |
|---|---|---|
| typical *furvus* ..... | 15.1 mm., or less | 1 |
| intergrade ..... | 15.2–16.4 mm. | 2 |
| typical *carinatus* ..... | 16.5 mm., or more | 3 |

W El int. 5/W El int. 4

| Subspecies | Range | Value |
|---|---|---|
| typical *furvus* ..... | 1.18, or more | 1 |
| intergrade ..... | 1.19–1.21 mm. | 2 |
| typical *carinatus* ..... | 1.22, or more | 3 |

TABLE 27

HYBRID INDEX VALUES FOR SAMPLES OF *Dicaelus furvus*.

| Values | Localities | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | E. Pa. | Md.-Va. | N. C. | Tenn. | W. Pa. | O.-Ill. | Ia.-Neb. | Mo.-Ark. | Ala.-Miss. |
| | | | | | Males | | | | |
| 6 | | | | | | | | 2 | 4 |
| 5 | | | | | | 4 | 5 | 9 | 5 |
| 4 | 2 | | | 1 | 1 | 3 | | 1 | |
| 3 | 3 | 2 | 1 | | 1 | 3 | | 1 | |
| 2 | 14 | 1 | 1 | | | 1 | | | |
| | | | | | Females | | | | |
| 6 | | | | | | | | 5 | 2 |
| 5 | | | | | | 2 | 7 | 1 | 5 |
| 4 | 1 | 1 | | 5 | 1 | 4 | 2 | 4 | 1 |
| 3 | 4 | 4 | 2 | 1 | 2 | 5 | | | |
| 2 | 13 | 2 | | | 2 | 1 | | | |

**Dicaelus (Paradicaelus) dilatatus** Say

The distinguishing characteristics of this species are in the keys.

This species ranges on the piedmont and coastal plain of eastern United States from central Massachusetts southward to northern Florida, and westward around the Appalachians on the Gulf Coast in the south, and through Ohio, Indiana and Illinois in the north, into the Mississippi Basin. The western limit is probably the 100th Meridian.

Several named forms, described originally as distinct species key out here, may be distinguished from one another as follows: *D. dilatatus* Say (type locality: restricted here to eastern Pennsylvania), size smaller (average length about 20-21 mm.), frontal impressions shallow, head and pronotum relatively smooth and shining, surface not coarsely rugose, sides of pronotum not sinuate and constricted posteriorly, (fig. 96a), nor broadly rounded, posterior transverse impression shallow; *D. carolinensis* Casey (type locality: Southern Pines, N. C.) and *D. planicollis* Le Conte (type locality: Georgia), size larger (average length about 22-23 mm.), frontal impressions moderately deep, head and pronotum decidedly rugose, sides of pronotum not constricted and sinuate posteriorly, posterior transverse impression shallow; the feature distinguishing these two is that the sides of the pronotum are more broadly rounded in *carolinensis* (fig. 96c) than in *planicollis* (fig. 96b); *D. dejeani* Dejean (type locality: restricted here to the coastal plain of Georgia), size larger than *planicollis*, (length usually 24-25 mm.), frontal impressions deep, dorsal surface of head and pronotum coarsely rugose, as in *planicollis*, sides of pronotum posteriorly constricted and sinuate or not (usually not constricted), posterior transverse impression deep. An additional form, similar to *dejeani* but differing in distribution (western Pennsylvania to southern Iowa) usually having the sides of the pronotum constricted, can be distinguished. The name *dejeani* has been applied to this group of specimens, but probably not correctly so.

The distinguishing characteristics of these forms seem to vary geographically, and these "species" are simply names applied to a continuum of variation.

To obtain samples of a statistically useful size it was necessary to group together specimens from a number of localities. The groupings have been made on two assumptions: first, that the species can be di-

vided into at least two geographical races; second, that the characters involved, especially size, vary clinally. The most distinctive groups of specimens are those from northeastern United States east of the Appalachians, westward to Harrisburg, Pennsylvania, and north of North Carolina; contrasted with specimens from localities in eastern United States, but west of the Appalachians, extending eastward to Pittsburgh, Pennsylvania, and north of the Gulf states. The remaining specimens, i.e. those from the Carolinas and Gulf states, were placed in two groups: a more northern one, including specimens from North Carolina (piedmont to coastal plain), South Carolina, and Georgia, and a second group including specimens from northern Florida (as far south as Gainesville), Alabama, and Mississippi (localities above and below Fall Line). The samples are discussed in sequence beginning with the northeasternmost (Mass.-Va.), proceeding southward on the east coast (N. C.-Ga.), westward on the Gulf Coast (Fla.-Miss.), and ending with the western Pennsylvania-Iowa sample (W. Pa.-Ia.). The characters to be discussed are those which vary geographically, or which have been used to distinguish the named forms included in this species.

The macrosculpture of the dorsal surface of the head and pronotum is usually less pronounced in the smaller, northeastern specimens than in the larger western and southeastern individuals. The macrosculpture of my series of Virginia and New Jersey specimens is slightly more pronounced on the average, and more specimens from North Carolina and southward have the integument coarsely rugose. The average maximum condition is reached in specimens from South Carolina and southward, westward, and northward, to the west of the Appalachians.

The depth of the frontal impressions of the head varies from shallow to deep following about the same pattern as the macrosculpture—the specimens from the northeast exhibiting the shallower impressions, becoming progressively deeper and more linear southward, the specimens included in the Fla.-Miss. and W. Pa.-Ia. samples with the deepest impressions. The posterior transverse impression is moderately deep in specimens of the Mass.-Va. sample, varying from shallow to deep in specimens of the remaining samples; shallow being prevalent in the N. C.-Ga. sample, deep being universal in the W. Pa.-Ia. sample

but occurring frequently in the Fla.-Miss. sample, along with the shallow and moderately deep conditions.

The sides of the pronotum posteriorly of all the specimens of the W. Pa.-Ia. sample are moderate to strongly sinuate. The sides of the pronotum appear to converge more strongly anteriorly in some specimens of the N. C.-Ga. and Fla.-Miss. samples than is usual for the Mass.-Va. sample. The disc of the pronotum appears to be more convex in specimens of the Mass.-Va. and W. Pa.-Ia. samples, flatter in some specimens of the N. C.-Ga. and Fla.-Miss. samples. A combination of configuration of the sides of the pronotum with convexity of the disc and depth of the posterior transverse impression, gives several different pronotal types which distinguish the named forms included in this species.

Actually, the three most distinctive types are *dilatatus, carolinensis* and sinuate (W. Pa.-Ia. sample). The *planicollis* pronotum bridges the gap between *carolinensis* and *dilatatus*, and the *dejeani* type bridges the gap between *dilatatus* and sinuate. All specimens of the Mass.-Va. sample have the *dilatatus* type of pronotum, and all specimens of the W. Pa.-Ia. sample have the sinuate type of pronotum. Specimens comprising the other two samples exhibit all types and intergrades between them. Table 28 contains a summary, by states, of the frequency distribution of the *dilatatus, carolinensis*, and sinuate types. The intermediate category includes specimens which have the *dejeani* or *planicollis* type.

These data show that the *carolinensis* type of pronotum is relatively rare and that its distribution is spotty. Specimens are known from: Southern Pines (7 out of 9, the other two intermediate between *carolinensis* and *dilatatus*); Columbia, South Carolina (taken with a *planicollis*-type specimen); Rock Bluff, Florida (coastal plain); Wadley, Bibb County (1 specimen, and four with a *dejeani*-type pronotum), and Langdale, Alabama. I contend that *carolinensis* is simply an extreme variant, genetic or otherwise, and should not be recognized taxonomically. In the following analysis of size and pronotal variation specimens having the *carolinensis*-type pronotum are included with the other specimens comprising the N. C.-Ga. and Fla.-Miss. samples.

The proportions of the pronotum vary geographically, with specimens of the W. Pa.-Ia. sample usually having a narrower pronotal base

than specimens comprising the other samples. The single ratio that best shows this is the width at widest point divided by width at base. Values for this ratio were obtained and are presented in table 29.

Size, as expressed by total length, also seems to vary geographically from the northeast southward to the Gulf states, with smaller specimens in the northeast and larger specimens southward (table 30).

Statistical analysis of the data for size and pronotal variation showed that the differences between the Mass.-Va. and W. Pa.-Ia. were of subspecific value (see Ball: 1954, tables 40-43), and a hybrid index was worked out utilizing the same method as outlined for *Dicaelus furvus*. A summary of the basis for assignment of hybrid index values is presented in table 31, and a frequency distribution of the values themselves is presented in table 32.

The suggested type locality for typical *dilatatus* falls within the area included in the Mass.-Va. sample; the type localities of *carolinensis*, *planicollis*, and *dejeani* fall within the areas represented by the N. C.-Ga. and Fla.-Miss. samples, the intergrades, and the W. Pa.-Ia. sample has not been named. As none of the names available really apply to the latter sample, I propose to call it *Dicaelus dilatatus sinuatus*. The northeastern population, represented by the Mass.-Va. sample, is the typical subspecies. The remaining names, since they apply to intergrading populations between the two extremes, may be profitably abandoned.

I suggest that population samples may be most effectively identified by determining the distribution of their hybrid index values. In the case of individual specimens, they may be named either on the basis of where they were collected or their hybrid index values: 2-3, *d. dilatatus;* 5-6, *d. sinuatus;* 4, intergrade.

A striking fact regarding the geographical distribution of the two races of this species is that in the southeast they are connected by a zone of intergradation probably some 600 miles in extent (approximate linear distance from Durham, North Carolina to Mobile, Alabama). In the state of Pennsylvania, typical specimens of *sinuatus* occur at Pittsburgh, and typical specimens of *dilatatus* at Harrisburg, localities which are about 150 miles apart. The zone of intergradation is either much narrower here than farther south, or the species does not occur in the intervening areas in Pennsylvania, due perhaps to ecologic fac-

tors, or time, or because the end points of the cline are specifically distinct.

**Dicaelus dilatatus dilatatus** Say

*Dicaelus dilatatus* Say, 1823:68.—Ibid., 1825: Pl. 24, fig. 3.

**Dicaelus dilatatus × sinuatus**

*Dicaelus dejeani* Dejean and Boisduval, 1830:206, t. 100, f. 3; [type specimen in Oberthür Coll. (fide Lindroth)]. Type locality: "Amerique septentrionale". Dejean, 1831:687. Le Conte, 1848:426; [*"habitat in provinciis australibus"*].

*Dicaelus planicollis* Le Conte, 1848:427. **New synonymy**; [type specimen a female, in Le Conte Coll., MCZ no. 5709.]. Type locality: "in Georgia ad montes"; (determined from original description).

*Dicaelus carolinensis* Casey, 1913:150; **New synonymy**; [type specimen a male, in Casey Coll., USNM no. 47357]. Type locality: Southern Pines, North Carolina; (determined from original description).

*Dicaelus dilatatus* Brimley (not Say), 1938:150. Löding, 1945:18.

Typical members of this subspecies (as defined in the preceding section) exhibit the following combination of characters: males, length 21.3 mm. or less, ratio PN:W/W base 1.04 or less; females, length 21.4 mm. or less, and the same value given for the males with respect to the pronotal ratio; pronotum and dorsal surface of head almost smooth to rugulose, frontal impressions relatively broad and shallow, posterior transverse impression of moderate depth. For more detailed information on classifying individual specimens see the preceding section dealing with geographical variation. As a general rule, specimens collected in the area including the New England States eastward to about 77° W. longitude and southward to southern Virginia may be regarded as members of this subspecies.

*Variation.*—A summary of data on variation in total length is presented in table 30 and of values for the ratio PN:W/W base in table 29 (Mass.-Va. sample). Width in a composite sample of *D. d. dilatatus* varies as follows: 20 males, 8.6-10.3 mm. (9.2 mm.); 20 females, 9.0-10.6 mm. (9.8 mm.). The lines of macrosculpture on the dorsal surface of the head and pronotum vary from deeper to shallower, these surfaces appearing more or less rugulose. The length of the groove on the dorsal inner edge of the left mandible varies from considerably less than one half the length of the distance from apex of labrum to apex of mandible, to considerably more than half this distance. There is slight

variation in the shape of the pronotum, as follows: sides more constricted anteriorly with lateral margins less arcuate; more arcuate anteriorly; lateral margins posteriorly almost parallel. The lateral margins of the pronotum are beaded in all specimens of a composite sample of 40. Number of setae near the apical margin of the 6th abdominal sternite varies as follows: 20 males, 2-5 (3.4); 20 females, 6-10 (7.4). Variation in the shape of the median lobe of the male genitalia is slight.

*Synonymical Notes.*—Reasons for the synonymy presented above have been given in the section dealing with geographical variation. The result is that the portion of the range of *Dicaelus dilatatus*, which is regarded as the intergrade zone between two subspecific components, includes the type localities of three named forms. Workers wishing to have a name for this segment may use *Dicaelus d. dejeani*, and those who do not accept my proposal of a new name for the W. Pa.-Ia. sample may expand the definition of Dejean's name to include the latter.

*Type locality.*—Say did not indicate a type locality in his description of this species. However, in the original description, a reference to *Carabus dilatatus* Melsh. [*nomen nudum*] is made, so possibly the type specimen was taken in eastern Pennsylvania. Pennsylvania is given as the state in which this species occurs, by Say (1825), and the figure on plate 24 of that volume represents a typical member of the northeastern population of *Dicaelus dilatatus*. Therefore, I consider the type locality to be eastern Pennsylvania.

*Notes on Immature Stages.*—Schaupp (1878) described the larva of *Dicaelus dilatatus* and figured it (1879: 21).

*Distribution.*—See the summary in conjunction with the diagnosis of this subspecies. I have collected specimens of *Dicaelus d. dilatatus* in the vicinity of Ithaca, New York, under cover in open fields and along stream margins. In the vicinity of Tuscaloosa, Alabama I have taken specimens classified here as intergrades, under wood chips and wet cardboard along the margin of a mixed deciduous wooded area, and under cover in open, river-bottom woodland.

Sixty-five males and fifty-one females collected in the following localities have been examined.

CONNECTICUT: Fairfield County; Stamford. Litchfield County; Cornwall. DISTRICT OF COLUMBIA: Woodridge. MARYLAND: Calvert County; Chesapeake Bch. Cecil County; Porter's Bridge. County not determined; Plummer Island, Wolfville. NEW HAMPSHIRE: County not determined; Cornish. NEW JERSEY:

"New Jersey". "N.J." Bergen County; Ramsey. Middlesex County; N. Brunswick. Passaic County; Oak Ridge, Paterson. Sussex County; Hopatcong. Warren County; Phillipsburg. County not determined; Greenwood L. NEW YORK: Kings County; Brooklyn. Orange County; Ft. Montgomery, Greenwood Lake. "Seneca County". "Tompkins County"; Ithaca. Ulster County; Big Indian Valley. Westchester County; Peekskill. MASSACHUSETT: "Mass." Essex County; Manchester. Hampden County; Chicopee. Hampshire County; Mt. Tom. Norfolk County; Cohasset. "Norwich County." Suffolk County; Cambridge. PENNSYLVANIA: "Pa." "Penn." Berks County; Reading, Shingleton. Centre County; State College. Cumberland County; Camphill, Enola, Le Moyne, N. Cumberland. Dauphin County; Harrisburg. Lebanon County; Campbell. Monroe County; Del. Water Gap. Northampton County; Easton, Wind Gap. Schuylkill County; Schuylkill. Sullivan County; Lopez. Wayne County; Honesdale. County not determined; Inglenook, Rockville. VIRGINIA: Rockbridge County; Natural Bridge. Warwick County; Newport News. County not determined; "Alex", Buffalo Ck, Great Falls, Skyland. WEST VIRGINIA: Greenbriar County; White Sulphur Springs.

Thirty-five males, and fifty-two females, classified here as intergrades between *d. dilatatus* and *d. sinuatus,* have been examined.

ALABAMA: Bibb County; The Sinks. Chambers County; Langdale. Clarke County; Salt Mtn. Fayette County; Fayette. Jackson County; Point Rock. Madison County; Monte Sano. Mobile County; Mt. Vernon. Randolph County; Wadley. Talladega County; Talladega. Tuscaloosa County; Fleetwood, Talladega St. Forest, Tuscaloosa. County not determined; Allstone, Tumblin Gap. FLORIDA: Alachua County; Gainesville. Liberty County; Camp Torreya. GEORGIA: "Geo". Fulton County; Atlanta. Limpkin County; Dahlonega. Rabun County; Rabun Gap. MISSISSIPPI: George County; Lucedale. Perry County; Richton. County not determined; Moon. NORTH CAROLINA: "N. Car." "N.C." Buncombe County; Asheville. Moore County; Southern Pines. Onslow County; New River. Orange County; Chapel Hill. Randolph County; Julian. SOUTH CAROLINA: "S.C." Oconee County; Clemson. Richland County; Columbia.

**Dicaelus dilatatus sinuatus,** new subspecies

*Dicaelus dilatatus* Blatchley (not Say), 1910: 116.
*Dicaelus dejeani* Casey (not Dejean), 1913: 153.

Typical members of *Dicaelus dilatatus sinuatus* may be recognized by the following combination of characters—males, length 23.0 mm. or more, value for ratio PN: W/W base 1.06 or more; females, length 23.4 mm. or more, value for pronotal ratio 1.05 or more; dorsal surface of head and pronotum rugose, frontal impressions of head deep and linear, posterior transverse impression of pronotum deeper than in typical subspecies.

*Description.*—Type, male. M[oun]t Pleasant, [Henry County], Iowa, Sept. 24, 1929, (White); [Iowa Nat. Hist. Sur. Coll.]. Length 23.3 mm., width 10.3 mm. Surface of integument generally opaque. Sculpture of dorsal surface of head and pronotum as in typical subspecies but lines deeper and more pronounced. Frontal impressions of head narrower and deeper than in typical *dilatatus,* more rugose.

Pronotum subcordate, 1.70 times wider than head, 1.55 times wider than long, 1.58 times wider at widest point than at apex, 1.08 times wider at widest point than at base, 1.57 times wider at base than at apex; lateral margins more reflexed than in *dilatatus,* posterior lateral oblique carinae absent so that lateral grooves and part of posterio-lateral impressions are confluent; disc almost flat medially, declivous laterally, more sharply declivous posteriorly than in the typical subspecies; posterior lateral impressions deep, median longitudinal impression as in typical subspecies; lateral margins arcuate anteriorly, strongly sinuate posteriorly, anterior angles as described for typical subspecies, posterior angles less rounded than in the typical subspecies. (see fig. 97).

Elytra 1.21 times wider than pronotum, 1.50 times longer than wide, striae and intervals as in typical subspecies.

Abdominal sternites as in typical subspecies, 6th sternite with a row of 9 setigerous punctures apically.

Male genitalia: median lobe average for the species.

*Variation.*—Data on variation in total length and in the ratio PN: W/W base (W. Pa.-Ia. sample) are presented in tables 29 and 30. Width in a composite sample of this subspecies varies as follows: 20 males, 10.2-12.2 mm. (10.8 mm.); 20 females, 10.5-13.1 mm. (12.0 mm.). Two males from Haywood County, North Carolina have the frontal impressions slightly broader than average for this subspecies, thereby approaching the condition seen in *D. d. dilatatus.* Surface markings of head and pronotum vary slightly. The groove on the left mandible varies from deep to obsolescent. The shape of the pronotum varies considerably but is usually consistent in showing a decided posterior sinuation of the lateral margins. One specimen, from Allegheny County, Pennsylvania, has the lateral margins weakly sinuate. The more anterior portion of the lateral margins varies from moderately to weakly arcuate, usually moderately so. The posterior transverse declivity is moderately deep in one male from Hot Springs, Madison County, North Carolina. All specimens examined have the lateral margins of the pronotum beaded throughout their length. Variation in the number of setigerous punctures on the 6th abdominal sternite is: 20 males, 5-11 (7.2); 20 females, 11-15 (12.5). The male genitalia exhibit slight and insignificant variation in shape.

*Distribution.*—This subspecies ranges in the Mississippi Valley from about 80° west longitude westward to southern Iowa, and probably to the 100th Meridian; east of the Mississippi, southward probably to southern Tennessee, and possibly to southern Texas to the west. Three specimens assigned to this subspecies were collected in southwestern North Carolina, in Haywood, and Madison Counties. The population represented by these specimens may have come through the Appalachians via the valleys of the Little Tennessee and French Broad Rivers, as the localities in which they were collected are near these valleys. Another possibility is that these specimens really belong to the intergrading populations and should not be included in this subspecies.

*Paratypes:* twenty-three males and twenty-five females, collected in the following localities, have been examined.

INDIANA: "Clark County". "Crawford County". "Franklin County". Knot County. "Lawrence County". Monroe County; Bloomington. Owen County; McCormicks Creek Pk. Sta. Tippecanoe County; Lafayette. "Vigo County". IOWA: "Desmoines County". Henry County; Mt. Pleasant. "Van Buren County". KENTUCKY: "KY." "Jessamine County". County not determined; Cumberland Gap. NORTH CAROLINA: Haywood County; Crestmont. Madison County; Hot Springs. OHIO: "Ohio". Cuyahoga County; Bedford Twp. Franklin County; Columbus. PENNSYLVANIA: "All'y". Allegheny County; Beck's Run, Wall. TENNESSEE: Cumberland County; Grassy Cove. Dickson County; Charlotte. Morgan County; Burrville. WEST VIRGINIA: Ritchie County; Petroleum.

These specimens are in the following collections: Museum of Comparative Zoology; Ball; Cornell University; University of Kansas; Kansas State College; R. T. Everly; W. S. Blatchley; Iowa Natural History Survey; University of Michigan, Museum of Zoology; Academy of Natural Sciences of Philadelphia; R. L. Chermock, University of Alabama.

TABLE 28

*Dicaelus dilatatus:* Frequency Distribution of Pronotal Types, by States.

| State | Type | | | |
|---|---|---|---|---|
| | *dilatatus* | *carolinensis* | sinuate | intermediate |
| N. C. ..... | | 8 | | 17 |
| S. C. ..... | | 1 | | 2 |
| Ga. ..... | | 1 | 2 | |
| Fla. ..... | | 1 | 2 | 6 |
| Ala. ..... | | 3 | 9 | 13 |
| Miss. ..... | | | 4 | 1 |

TABLE 29

*Dicaelus dilatatus:* Variation in Ratio PN: W/W base.

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | | Males | | |
| Mass.-Va. ..... | 66 | 1.00–1.06 | 1.02 ± 0.001 | 0.01 ± 0.00 | 0.9 |
| N. C.-Ga. ..... | 23 | 1.01–1.10 | 1.04 ± 0.004 | 0.02 ± 0.002 | 1.8 |
| Fla.-Miss. ..... | 12 | 1.01–1.09 | 1.04 ± 0.009 | 0.03 ± 0.006 | 2.8 |
| W. Pa.-Ia. ..... | 23 | 1.03–1.13 | 1.08 ± 0.004 | 0.02 ± 0.003 | 1.8 |
| | | | Females | | |
| Mass.-Va. ..... | 49 | 1.00–1.07 | 1.02 ± 0.002 | 0.02 ± 0.002 | 1.8 |
| N. C.-Ga. ..... | 18 | 1.00–1.07 | 1.02 ± 0.004 | 0.02 ± 0.003 | 1.9 |
| Fla.-Miss. ..... | 24 | 1.00–1.10 | 1.04 ± 0.004 | 0.02 ± 0.003 | 1.8 |
| W. Pa.-Ia. ..... | 26 | 1.05–1.12 | 1.08 ± 0.004 | 0.02 ± 0.003 | 1.8 |

TABLE 30

*Dicaelus dilatatus:* Variation in Total Length (mm.).

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | | Males | | |
| Mass.-Va. ..... | 66 | 17.9–23.0 | 20.3 ± 0.12 | 0.95 ± 0.08 | 5.0 |
| N. C.-Ga. ..... | 23 | 20.1–24.6 | 22.2 ± 0.29 | 1.38 ± 0.20 | 6.0 |
| Fla.-Miss. ..... | 12 | 23.3–26.8 | 24.4 ± 0.35 | 1.16 ± 0.25 | 5.0 |
| W. Pa.-Ia. ..... | 23 | 21.9–26.2 | 24.0 ± 0.20 | 0.97 ± 0.14 | 4.0 |
| | | | Females | | |
| Mass.-Va. ..... | 49 | 18.5–22.2 | 20.6 ± 0.12 | 0.81 ± 0.08 | 4.0 |
| N. C.-Ga. ..... | 18 | 20.4–25.6 | 22.6 ± 0.32 | 1.33 ± 0.22 | 6.0 |
| Fla.-Miss. ..... | 24 | 22.7–26.8 | 24.9 ± 0.20 | 0.98 ± 0.14 | 4.0 |
| W. Pa.-Ia. ..... | 26 | 21.9–26.6 | 24.7 ± 0.26 | 1.31 ± 0.18 | 5.3 |

TABLE 31

SUMMARY OF BASIS FOR ASSIGNMENT OF HYBRID INDEX VALUES.

Males

Length

| Subspecies | Range | Value |
|---|---|---|
| typical *dilatatus* ..... | 21.3 mm., or less | 1 |
| intergrade ..... | 21.4–22.9 mm. | 2 |
| typical *sinuatus* ..... | 23.0 mm., or more | 3 |

PN: W(wp)/W base

| Subspecies | Range | Value |
|---|---|---|
| typical *dilatatus* ..... | 1.04, or less | 1 |
| intergrade ..... | 1.05 | 2 |
| typical *sinuatus* ..... | 1.06, or more | 3 |

Females

Length

| Subspecies | Range | Value |
|---|---|---|
| typical *dilatatus* ..... | 21.4, or less | 1 |
| intergrade ..... | 21.5–23.3 mm. | 2 |
| typical *sinuatus* ..... | 23.4 mm., or more | 3 |

PN: W(wp)/W base

| Subspecies | Range | Value |
|---|---|---|
| typical *dilatatus* ..... | 1.04, or less | 1 |
| intergrade ..... | 1.05 | 2 |
| typical *sinuatus* ..... | 1.06, or more | 3 |

TABLE 32

HYBRID INDEX VALUES FOR SAMPLES OF *Dicaelus dilatatus*.

| Values | | Localities | | |
|---|---|---|---|---|
| | | Males | | |
| 6 | | 1 | 3 | 18 |
| 5 | | 5 | 1 | 3 |
| 4 | 2 | 8 | 8 | 2 |
| 3 | 12 | 5 | | |
| 2 | 52 | 4 | | |
| | | Females | | |
| 6 | | 2 | 8 | 21 |
| 5 | | 1 | 3 | 5 |
| 4 | 3 | 3 | 13 | |
| 3 | 4 | 10 | | |
| 2 | 42 | 2 | | |

**Dicaelus (Paradicaelus) sculptilis** Say

The characters given in the key will separate *Dicaelus sculptilis* from the other species of the subgenus *Paradicaelus.*

This species ranges from Virginia (probably on piedmont and coastal plain), northward to Pennsylvania (south of the mountains), westward to the 100th. Meridian; southward to southern Arkansas in the Mississippi Basin, and northward to southern Manitoba; on the eastern slope of the Rocky Mountains to an elevation of at least 5000′, southward to New Mexico, as far north, at least, as Colorado.

*Variation.*—Geographical variation within this species is complicated and must be viewed as a whole. Therefore it is presented here as such, rather than describing the variation of each subspecies separately. In the course of the discussion the subspecies are defined.

For purposes of analysis, specimens collected at different localities frequently had to be grouped together to form samples of a suitable size. Three considerations governed the sample composition: 1. approximate geographical unity; 2. approximate morphological homogeneity; 3. isolation of geographically extreme specimens. This latter point was employed to emphasize morphologically extreme conditions which seemed to characterize geographically extreme samples.

These characters vary geographically: size, sculpture of pronotum and proepisternum, slope of lateral discal declivity of pronotum, total number of umbilicate punctures on the elytra, and arrangement of elytral striae. These variables are expressed in quantitative terms, excepting pronotal convexity and rugosity.

Data on variation in total length are presented graphically in table 33 and may be roughly summarized as follows: mean values high in southern Mississippi Basin area; intermediate in North Central States, and northern Mississippi Basin area and New Mexico; low in Colorado, south-central Canada, and in northeastern United States.

Surface sculpture of the pronotum and proepisternum varies considerably. All of the specimens in the Ark., and Tenn. samples and 97 per cent of the Mo.-Okla. sample have the pronotal surface with lateral grooves and median posterior area strongly to moderately rugose, the transverse discal lines moderate to coarse, and the areas between the latter rugulose, not smooth. Three per cent of the Mo.-Okla. sample has these characters slightly less pronounced but more so than in the

more northern series. Contrasting with this, the specimens comprising the more northern samples, with the exception of the S. Iowa series, usually exhibit smoother pronota. The latter sample exhibits smooth and moderately rugose pronota with about equal frequencies. Further, on the average, the pronota of the specimens comprising the S. Ont.-S. Ill. sample are slightly more rugose than the more eastern and northern series, but are more like these than like the more southern samples. The rugosity of the proepisternum varies as does that of the pronotum. Relative convexity of the pronotal disc also was found to vary geographically, the slope of the lateral declivity being either slight, moderate, or pronounced. Specimens from the southern Mississippi Basin area exhibit relatively flat pronotal discs as compared with those from farther north, with the southern Iowa specimens again about intermediate in this character, and the specimens from S. Ont.-S. Ill. tending toward the Iowa specimens but closer to those with the most convex discs.

The integument of specimens from the southern Mississippi Basin area is usually more opaque than that of specimens from farther north and west.

Using pronotal sculpture and discal convexity as the principal diagnostic features, and size and surface lustre for support, *Dicaelus sculptilis* can be divided into two subspecies " groups ". (This term is used for the present because one of these units can be divided into two, using surface sculpture of the elytra.) The Mo.-Okla. and Ark. samples constitute one homogeneous unit and are distinguished as follows; pronotum and proepisternum coarsely to moderately rugose, lateral declivities of the disc of the pronotum gently sloping, the disc appearing relatively flat, length of males on the average greater than 18.6 mm., length of females on the average greater than 19.2 mm., surface opaque to subopaque (*s. sculptilis*). The pronota of specimens belonging to the second group are completely smooth to rugulose, the lateral declivities of the disc relatively steep, the disc therefore appearing relatively convex, length of males on the average less than 18.6 mm., length of females averaging less than 19.2 mm., integument shining to subopaque.

By using these characters I am able to place almost all specimens that I have seen in either one group or the other, with the exception of the southern Iowa series, and a few specimens from Indiana and Illi-

nois. I have not seen any specimens of this species from eastern or central Missouri, but suspect that if populations of the species occur there they will be intermediate in their characters between the northern and southern subspecies.

Elytral sculpture varies in two features: the number of umbilicate punctures on intervals 2, 4, and 6, and the extent of interruption of the normal course of the elytral striae. I have expressed both of these variables numerically. The umbilicate punctures may be formed either independently of the elytral striae, or as a result of the crenulation of the latter. The second type is formed, apparently, by a forking and short encroachment of the stria into its adjacent interval, cutting off a small portion of the latter as an "island"; the two parts of the fork joining again below the island. Sometimes the encroachment occurs without an actual forking of the stria so that the small portion of the interval isolated from the main portion is not completely surrounded by a stria. This second condition was not considered in making counts of the number of umbilicate punctures. Further, only those punctures on intervals 2, 4, and 6 were counted. Because appreciable variability occurred in the number of punctures on each elytron of individual specimens, the total for both elytra together was taken. Results of the umbilicate puncture counts are presented in table 34. Specimens from the Rocky Mountain-southern-central Canada-northern Mississippi Basin area have relatively few umbilicate punctures (excepting the Minn. sample); specimens from he Mississippi Basin area in the south (excluding Tenn. specimens) and to the east of the Mississippi River in the north have relatively many umbilicate punctures; and specimens from southern Iowa and southern Minnesota are intermediate.

The extent of interruption of the normal course of the elytral striae and the consequent degree of dissection of the elytral intervals was expressed in terms of the number of complete crossings of an interval by its adjacent striae, exclusive of those occurring on the apical declivity. The weakness in this method was that in those specimens in which the striae were highly disorganized and the intervals much dissected, it was impossible to get an accurate count of the number of cross-overs, but for the majority of specimens this method was found to be satisfactory. As in the case of the umbilicate punctures, appreciable individual variation was found from one elytron to the other, so the value given to a

specimen is the sum of the cross-overs on each elytron. Results of these counts are presented in table 35.

A character index was made by dividing the number of strial cross-overs by the number of umbilicate punctures for each specimen. Results, presented in table 36, seem to indicate that two groups of samples are present; one very homogeneous with respect to this index, and one quite heterogeneous. I conclude that the N. M., Colo., Man., Minn., N. Ia., and N. Ill. samples constitute one subspecies (*s. upioides*) and that the remaining samples constitute another (which is really two, the southerly *s. sculptilis* and the northerly *s. intricatus* as is indicated by other characters), with the S. Iowa sample, with its unusually high coefficient of variation, as the " blend population ".

*The Tennessee Sample:* This sample consists of five specimens, four males and one female, collected either at Memphis, Charlotte, (Dixon Co.), or Reelfoot Lake, stations which are located in western Tennessee. This series is morphologically quite distinct in elytral sculpture from the three races discussed above but it is not named here because of the paucity of specimens and because of the extensive variability in elytral sculpture exhibited by the other subspecies.

In size and pronotal characteristics this sample goes with the geographically adjacent southern subspecies (i.e. specimens relatively large in size, with pronotal disc flattened, and surface rugose). The elytral striae are straight and do not cross the intervals which are, therefore, not dissected. The largest number of umbilicate punctures on a single specimen is ten. Three specimens exhibit series of small punctures in the alternate intervals which are not umbilicate.

One other specimen deserves mention: a single male, labelled " Ohio." This individual is of moderate size, with the pronotal disc relatively smooth, and moderately convex. The elytral striae are straight, not crenulate, and the intervals have no punctures, umbilicate or otherwise. I originally identified this specimen as *Dicaelus dilatatus* but placed it in *sculptilis* after noting that the elytral striae were punctate, and that the internal sac of the median lobe had four spines instead of three. If we assume that this specimen was collected in extreme southern Ohio (which is not unlikely since I have no specimens of *sculptilis intricatus* from that area), and that it represents a distinct population which ranges along the western edge of the Appalachian

Mountains, northward to the Ohio River and westward to the vicinity of the Mississippi, then possibly the Tennessee specimens represent intergrades between it and the subspecies which we know is on the western side of this river.

In any event, the paucity of material from this region does not permit any conclusions to be drawn other than that the specimens observed are different from those occurring elsewhere.

*Summary and Discussion.*—Using the characters presented above, the geographically variable species *Dicaelus sculptilis* can be divided into at least two, and probably three, geographical races. The two northern races, distinguished from one another by differences in elytral sculpture, differ from the more southern subspecies in that they are, on the average, smaller in size, with the pronotum smoother and the lateral declivities of the disc steeper, and the integument more shining.

**Dicaelus s. sculptilis** Say

*Dicaelus sculptilis* Say, 1825:68, fig. 12, Type locality: "Missouri", (Thomas Nuttall).—Horn, 1880:52, [in part].—Leng, 1920:62.—Csiki, 1928-31: 918.

*Dicaelus ocellatus* Blatchley, Ent. News, Vol. XXIII, p. 77, (1912); ["1 ♂, 1 ♀, H. Springs, Ark., 10-6, (Bolter coll.)"].—Leng, ibid.—Csiki, ibid.

The diagnostic features of this subspecies are discussed in detail above.

Specimens representing *Dicaelus s. sculptilis* have been collected in western Missouri, eastern Kansas, eastern Oklahoma, and central and eastern Arkansas.

*Variation.*—Number of setigerous punctures on the 6th abdominal sternite: males, 5-8 (7); females, 10-14 (11).

*Synonymical Notes.*—The original description of this subspecies was based on a single specimen collected in "Missouri." Because Say's type is not available for study, and because the figure and description do not mention or illustrate the critical subspecific characters, and in the absence of more specific locality data, we cannot accurately determine to which population the type specimen belongs. However, the north western race has the elytra sculptured differently from that which is figured by Say, so it can be eliminated from this discussion. Each of the other two races has been named; the northeastern one, *intricatus* by Le Conte, in 1873, the southern one, *ocellatus* by Blatchley, in 1912. I contend

that Le Conte, by applying a new name to the northeastern race, fixed the southern population as typical. Therefore, I regard *D. ocellatus* Blatchley as a synonym of *D. s. sculptilis* Say since the diagnostic features of the former are simply extreme variants of the distinguishing characteristics of the latter subspecies.

I have seen only three specimens of this species from Missouri, all of which can be assigned to the more southerly population.

Thirteen males and twenty-nine females from the following localities have been examined.

ARKANSAS: "Ark". Benton County; Rogers. Polk County; Rich Mtn. Pulaski County; Little Rock. County not determined; Magazine Mt. KANSAS: "Kan." Douglas County; Lawrence. "Franklin County". "Riley County." MISSOURI: "Mo." "Platte County." OKLAHOMA: "Latimer County". "Tulsa County".

The morphological characters of fifteen males and seventeen females collected in the following localities suggest that they are intermediate between all three subspecies.

IOWA: "Iowa". "Henry County; Mt. Pleasant. Iowa County; S. Amana. "Jasper County". "Linn County". "Louisa County". "Poweshiek County". "Scott County". Story County; Ames. "Van Buren County". "Wapello County". County not determined; Boonsboro.

**Dicaelus s. intricatus** Le Conte

*Dicaelus sculptilis intricatus* Le Conte, 1873: 324.
*Dicaelus sculptilis* Horn, 1880: 51-52, [in part].—Blatchley, 1910: 115.—Leng, 1920: 62, [in part].—Csiki, 1928-31: 918, [in part].
*Dicaelus intricatus* Chaud. (? i.l.); [reference copied from Csiki, ibid.].

The diagnostic features of this subspecies are discussed in detail above.

The geographical range of *Dicaelus s. intricatus* is Virginia to Pennsylvania south of the mountains in that state, westward to Illinois, and northward to southern Michigan. In northern Illinois this race is replaced by *D. s. upioides.* The boundaries are probably these: western, the Mississippi in southern Illinois; southwestern possibly the Ohio River; northern, probably the Transition Zone forests; southeastern, unknown.

*Variation.*—Number of setigerous punctures on 6th abdominal sternite: males, 5-8 (7); females, 8-13 (10). The usual number of

setigerous punctures on the pronotum is two on each side. However, a few specimens have more than two (see table 37).

The name used for this subspecies, *Dicaelus s. intricatus*, first appeared in the literature in an article published by Le Conte in 1873. I quote from it: "39. *Dicaelus sculptilis* Say. The more convex and shining race of this species has been named *intricatus* by Baron Chaudoir." The article contains other synonymical notes on North American Coleoptera made by Le Conte as a result of a visit to Europe, during which time he studied several collections containing types of North American species of beetles. Apparently Chaudoir's collection was one of those studied by Le Conte. Possibly, then, the name *intricatus* was a *label name* on a specimen of *Dicaelus sculptilis* in the Baron's collection.

The description given for *D. s. intricatus* fits the two more northern subspecies. I apply it to the eastern race because the western race is not represented in Le Conte's collection, and possibly, therefore, he was not familiar with it. Further, it seems that if Chaudoir's specimen represented the northwestern race, Le Conte would have mentioned the elytral sculpture as well as lustre and convexity, since the elytral sculpture of this subspecies is quite different from that of typical *sculptilis*.

TABLE 37

SPECIMENS EXHIBITING MORE THAN 2 SETIGEROUS PUNCTURES ON ONE OR BOTH SIDES OF THE PRONOTUM.

| Locality | No. Setigerous Punctures on Margin of Pronotum | |
|---|---|---|
| | Left | Right |
| "Pa." | 3 | 2 |
| Columbus, O. | 3 | 2 |
| Lafayette, Ind. | 3 | 3 |
| Ann Arbor, Mich. | 4 | 4 |
| " " " | 4 | 4 |
| " " " | 2 | 3 |
| " " " | 3 | 2 |
| " " " | 2 | 3 |

*Type Locality.*—For the present, and until the locality in which the type specimen was collected can be determined, we may regard the type locality of this race as eastern Pennsylvania.

*Specimens Examined.*—Fifty-four males and forty-four females collected in the following localities have been studied.

INDIANA: "Indiana". "Ind". "Forest County". "Greene County". "Knox

County". "Marion County". "Monroe County". "Posey County". Tippecanoe County; Lafayette. "Vigo County". MARYLAND: County not determined; Great Falls. MICHIGAN: "Michigan". Washetenaw County; Ann Arbor, Dexter. Wayne County; Detroit, River Rouge. OHIO: "Ohio". Franklin County; Columbus. Hancock County; Allen twp. Greene County; Yellow Springs. "Lucas County". Ottawa County; S. Bass Is. "Preble County". "Wood County". ONTARIO: Essex County: Pelee Island. PENNSYLVANIA: "Pen". "Pa." Allegheny County; Allegheny, Indian Crk., Pittsburg, Wall. Cumberland County; Camphill. "Somerset County". VIRGINIA: "Va".

**Dicaelus s. upioides,** new subspecies

The diagnostic features of this subspecies are discussed in detail above.

This subspecies is probably an inhabitant of Transition Zone forests in south central Canada and along the eastern edge of the Rockies.

*Description.*—Type, male. Winnipeg, Man. [itoba], 28.V.17, (J. B. Wallis), [Chamberlain Coll., Cornell Univ.].

Male. Length 16.1 mm., width 7.9 mm. Color of dorsal surface uniform black, shining, palpi and median areas of ventral surface piceous (specimen apparently somewhat teneral), apical six segments of antennae pale reddish brown.

Head with sculpture of dorsal surface and frontal impressions as in typical subspecies.

Pronotum as in *s. sculptilis;* surface sculpture differing as follows: lateral grooves and posterior median area decidedly less rugose, almost smooth, transverse and oblique discal strioles fewer, more widely spaced, spaces between them smooth, not rugulose; lateral declivities of disc steeper, the disc appearing therefore more convex than in the typical subspecies; median longitudinal impression deep, terminating anteriorly in the deeply and broadly impressed anterior transverse impression, and posteriorly in the posterior transverse impression; thoracic pleurites and lateral portion of sternites rugulose.

Elytra with striae moderately impressed, finely punctate, not continuous from base almost to apex as in typical subspecies, but broken many times, and frequently crossing intervals 2, 4, and 6; intervals 3, 5, and 7, smooth, as in typical subspecies, intervals 2, 4, and 6 with a few umbilicate punctures; interval 7 carinate in basal 1/7.

Abdominal sternites rugulose laterally, smooth medially; 6th abdominal sternite with ten punctures.

Male genitalia average for the species.

*Variation.*—Number of setigerous punctures on 6th abdominal sternite: males 6-9 (7); females 5-13 (10).

*Paratypes.*—Forty-six males and twenty-five females collected in the following localities have been examined.

COLORADO: "Colorado." "Col." El Paso County; Colorado Springs, N. Cheyenne Canyon. Gunnison County; Gunnison. Larimer County; Poudre Canyon. Montrose County; Ute Pass. San Miguel County; Telluride. ILLINOIS: "C. Ill." "N. Ill." Cook County; Chicago, Lagrange. McHenry County; Algonquin. Wabash County; Richmond and Lawrence. County not determined; Beverly Hill, Edgebrook. IOWA: Buchanan County; Independence. "Dickinson County"; Spirit Lake. "Emmet County." "Lyon County." "Kosuth County." Palo Alto County; Ruthven. "Story County." MANITOBA: Aweme, Cortwright, Makinak, Winnpeg. MINNESOTA: "Minn." "Hennepin County." Ramsey County; St. Paul. County not determined; Grand Forks. NEW MEXICO: Lincoln County; Ruidoso. Otero County; Bent. ONTARIO: County not determined; Kenora. SOUTH DAKOTA: Brookings County; Volga. WISCONSIN: "Wis." NO LOCALITY DATA: four males.

These specimens are in the following collections: University of Michigan, Museum of Zoology; Cornell University; Museum of Comparative Zoology; Bureau of Plant Industry, Harrisburg, Pa.; United States National Museum; American Museum of Natural History; California Academy of Sciences; New York State Museum; Iowa Natural History Survey; Illinois Natural History Survey; University of Minnesota; Ball.

### Subgenus **Dicaelus** (*s. str.*)

*Dicaelus* Bonelli, [in part], 1813:446; (species originally included: *D. purpuratus, violaceus, elongatus,* and *teter*).

GENOTYPE: *Dicaelus violaceus* Bonelli (= *purpuratus* Bon.); (designated by: Hope, Coleopterist's Manual, Vol. II, p. 82, 1838).

The distinctive characteristics of this subgenus are summarized in the key and in the discussion of subgeneric classification of *Dicaelus* (*s. lat.*).

The members of this subgenus range on the piedmont and coastal plain of eastern United States northward to Massachusetts and southward to southern Florida; in the Ohio River Basin; westward across the plains to the Rocky Mountains and southeastern Arizona, and southward on the Mexican plateau to southern Tamaulipas. In altitude the subgenus ranges from sea level to at least 3000′ in the Smoky Mountain area.

TABLE 33

*Dicaelus sculptilis:* Variation in Total Length (mm.).

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| N. M. | 2 | 17.0–18.5 | 17.8 | | |
| Col. | 7 | 14.9–17.2 | 16.1 | | |
| Man. | 6 | 15.0–17.4 | 16.2 | | |
| Minn. | 9 | 15.0–17.3 | 16.3 | | |
| Wisc. | 1 | 15.6 | | | |
| N. Ia. | 4 | 15.2–16.0 | 15.7 | | |
| N. Ill. | 13 | 15.6–18.4 | 17.5 | | |
| S. Ia. | 15 | 16.0–19.1 | 17.4 ± 0.20 | 0.78 ± 0.14 | 4.5 |
| Mich. | 14 | 15.7–18.3 | 17.1 ± 0.18 | 0.69 ± 0.13 | 4.0 |
| Va.-Pa. | 14 | 15.3–18.3 | 16.4 ± 0.20 | 0.76 ± 0.14 | 4.6 |
| S. Ont.-S. Ill. | 26 | 16.4–19.5 | 17.9 ± 0.15 | 0.78 ± 0.10 | 4.2 |
| Mo.-Okla. | 11 | 18.6–20.8 | 20.2 | | |
| Ark. | 2 | 21.0–21.6 | 21.3 | | |
| Tenn. | 4 | 19.3–21.8 | 20.8 | | |
| | | Females | | | |
| Col. | 5 | 15.5–17.4 | 16.2 | | |
| S. D. | 1 | 16.6 | | | |
| Man. | 5 | 15.9–18.1 | 16.7 | | |
| Minn. | 5 | 15.6–17.0 | 16.4 | | |
| N. Ia. | 8 | 14.3–16.9 | 15.7 | | |
| N. Ill. | 2 | 17.3–19.6 | 18.4 | | |
| S. Ia. | 15 | 16.0–18.4 | 17.3 ± 0.16 | 0.64 ± 0.12 | 3.7 |
| Mich. | 12 | 16.3–18.9 | 17.7 | | |
| Va.-Pa. | 10 | 16.1–18.3 | 17.1 | | |
| S. Ont.-S. Ill. | 22 | 16.8–20.2 | 18.5 ± 0.18 | 0.84 ± 0.13 | 4.6 |
| Mo.-Okla. | 19 | 18.0–21.9 | 20.2 ± 0.25 | 1.09 ± 0.18 | 5.4 |
| Ark. | 6 | 20.7–26.0 | 22.7 | | |
| Tenn. | 1 | 19.3 | | | |

TABLE 34

*Dicaelus sculptilis:* Variation in Total Number of Ocellate Punctures on Elytra.

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| N. M. | 2 | 3–10 | 6.5 | | |
| Col. | 12 | 2–16 | 5.9 | | |
| S. D. | 1 | 9 | | | |
| Man. | 10 | 3–22 | 9.5 | | |
| Minn. | 14 | 10–30 | 20.4 ± 1.43 | 5.5 ± 1.01 | 27 |
| Wisc. | 1 | 3 | | | |
| N. Ia. | 12 | 7–20 | 12.8 | | |
| N. Ill. | 12 | 6–27 | 14.4 | | |
| S. Ia. | 32 | 11–43 | 23.3 ± 1.44 | 8.1 ± 1.02 | 35 |
| Mich. | 26 | 7–54 | 32.4 ± 2.00 | 10.2 ± 1.41 | 31 |
| Va.-Pa. | 25 | 14–44 | 26.8 ± 2.00 | 7.2 ± 1.02 | 27 |
| Ont.-S. Ill. | 46 | 5–53 | 24.6 ± 1.25 | 8.5 ± 0.88 | 34 |
| Mo.-Okla. | 29 | 15–45 | 25.6 ± 1.34 | 7.2 ± 0.95 | 28 |
| Ark. | 8 | 19–42 | 28.9 | | |
| Tenn. | 5 | 2–10 | 4.0 | | |

TABLE 35

*Dicaelus sculptilis:* Variation in Total Number of Strial Cross-overs on Elytra.

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| N. M. | 2 | 32–34 | 33.0 | | |
| Col. | 12 | 16–33 | 25.0 | | |
| S. D. | 1 | 14 | | | |
| Man. | 10 | 20–34 | 25.9 | | |
| Minn. | 14 | 8–34 | 21.5 ± 0.74 | 2.76 ± 0.52 | 13 |
| Wisc. | 1 | 26 | | | |
| N. Ia. | 12 | 13–33 | 23.3 | | |
| N. Ill. | 12 | 11–26 | 18.8 | | |
| S. Ia. | 32 | 6–30 | 15.7 ± 1.07 | 6.06 ± 0.76 | 39 |
| Mich. | 26 | 2–15 | 6.6 ± 0.61 | 3.10 ± 0.43 | 47 |
| Va.-Pa. | 25 | 0–16 | 6.0 ± 0.78 | 3.92 ± 0.55 | 65 |
| Ont.-S. Ill. | 47 | 1–19 | 6.9 ± 0.62 | 4.28 ± 0.44 | 62 |
| Mo.-Okla. | 29 | 0–20 | 7.3 ± 0.86 | 4.60 ± 0.60 | 63 |
| Ark. | 8 | 0–14 | 6.1 | | |
| Tenn. | 5 | 0 | | | |

TABLE 36

*Dicaelus sculptilis:* Variation in Elytral Index Values.

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| N. M. | 2 | 3.40–16.0 | 9.70 | | |
| Col. | 12 | 1.62–14.0 | 6.02 ± 1.03 | 3.57 ± 0.73 | 59 |
| S. D. | 1 | 1.56 | | | |
| Man. | 10 | 1.18–8.00 | 3.66 ± 0.83 | 2.62 ± 0.58 | 72 |
| Minn. | 14 | 0.33–2.14 | 1.12 ± 0.14 | 0.54 ± 0.10 | 48 |
| Wisc. | 1 | 8.00 | | | |
| N. Ia. | 12 | 0.72–3.58 | 2.05 ± 0.29 | 1.07 ± 0.20 | 52 |
| N. Ill. | 12 | 0.56–4.20 | 1.50 ± 0.27 | 0.94 ± 0.19 | 63 |
| S. Ia. | 32 | 0.14–1.19 | 0.71 ± 0.36 | 1.04 ± 0.13 | 132 |
| Mich. | 26 | 0.07–0.32 | 0.23 ± 0.03 | 0.15 ± 0.02 | 65 |
| Va.-Pa. | 25 | 0.00–1.07 | 0.26 ± 0.05 | 0.26 ± 0.04 | 100 |
| Ont.-S. Ill. | 46 | 0.04–1.00 | 0.34 ± 0.04 | 0.27 ± 0.02 | 80 |
| Mo.-Okla. | 29 | 0.00–0.87 | 0.32 ± 0.04 | 0.22 ± 0.03 | 69 |
| Ark. | 8 | 0.00–0.74 | 0.23 ± 0.08 | 0.24 ± 0.06 | 104 |
| Tenn. | 5 | 0.00 | | | |

## *Key to Species of Subgenus Dicaelus*

1. Color of dorsal surface of elytra either blue, purple, coppery red, or green, not black ..... 2
   Color of dorsal surface of elytra black ..... 5
2. Color of dorsal surface of elytra coppery red, or metallic green, 6th abdominal sternite usually, but not always, lacking a patch of short setae ..... *D. p. splendidus* Say
   Color of the dorsal surface of elytra purple or blue, 6th abdominal sternite with or without a patch of short setae ..... 3
3. Elytral intervals 1-6 of about the same degree of convexity, disc of pronotum without flattened lateral areas in addition to lateral grooves, 6th abdominal sternite usually with a patch of short setae ..... *D. p. purpuratus* Bonelli
   Elytral intervals 3 and 5 more convex than intervals 2, 4, and 6, disc of pronotum with flattened lateral areas in addition to lateral grooves, 6th abdominal sternite without a patch of short setae ..... 4
4. Sides of pronotum broadly arcuate, not sinuate posteriorly, color deep purple ..... *D. p. quadratus* Le Conte
   Sides of pronotum narrowly arcuate anteriorly, distinctly sinuate posteriorly, color bright violaceous ..... *D. p. darlingtoni* Fall
5. Elytral striae 6 and 7 joined at apex of interval 7, stria 7 not extending to apex of elytron, stria 5 free apically, interval 7 distinctly above plane of intervals 1-6 throughout its length, not flattening apically, 2nd, 3rd, 4th, and 5th abdominal sternites on each side with a deep transverse groove, frontal impressions of head deep and linear ..... *D. costatus* Le Conte

Elytral striae 6 and 7 not joined apically, 7 continuing to apex of elytron, 5 and 6 joined; interval 7 strongly carinate basally, but flattening apically, 2nd, 3rd, 4th, and 5th abdominal sternites without transverse grooves laterally, frontal impressions of head broad and shallow, not deep and linear ..... 6

6. Elytral intervals smooth, without small setigerous punctures bearing short hairs, striae with relatively large punctures, pronotum either not beaded laterally, or beaded in apical 1/3 ± .... *D. crenatus* Le Conte

At least intervals 3 and 5 with two or three series of small setigerous punctures, striae with smaller punctures or impunctate, pronotum beaded laterally at least in apical 1/3, and usually in apical 1/2 to 2/3 the length of lateral margin ..... 7

7. Intervals, 2, 4, and 6 more opaque than intervals 1, 3, and 5, the former with numerous setae scattered over the surface ..... *D. a. alternans* Dejean

Intervals 2, 4, and 6 not more opaque than 1, 3, and 5, the former impunctate ..... *D. a. subtropicus* Casey

The species of this subgenus may be arrayed in three groups, as follows.

A. *purpuratus* group.

Mandibles of *Dicaelus* Type IIa (fig. 85a-d), pronotum with purple pigment at least laterally, elytra either purple or bright coppery red in color, elytral striae 6 and 7 not joined apically, 7 continuing to apex of elytron, elytral striae 5 and 6 joined apically, apical portion of median lobe straight, dorsal apical hook present and medial in position (figs. 112a and b), spines of internal sac broad at base, acuminate or not apically, dorsal apical plate not scutellate medially.

Included species:

*Dicaelus purpuratus* Bonelli

Exerge *purpuratus*

*Dicaelus purpuratus purpuratus* Bonelli

*Dicaelus purpuratus splendidus* Say

Exerge *quadratus*

*Dicaelus purpuratus quadratus* Le Conte

*Dicaelus purpuratus darlingtoni* Fall

B. *crenatus* group.

Mandibles of *Dicaelus* Type IIa, color black, elytral striae 6 and 7 not joined apically, 7 continuing to apex of elytron, striae 5 and 6 joined apically, apical portion of median lobe obtuse, or inclined toward right, apical hook present, to left of median plane (figs. 114b and 115b), spines of internal sac acuminate or not apically, median portion of dorsal apical plate scutellate or not (fig. 115c).

Included species:

*Dicaelus crenatus* Le Conte

*Dicaelus alternans alternans* Dejean

*Dicaelus alternans subtropicus* Casey

C. *costatus* group.

Mandibles of *Dicaelus* Type IIb (figs. 86a and b), color black, elytral striae 6 and 7 joined at apex of interval 7, stria 7 not extending to apex of elytron, stria 5 free apically, apical portion of median lobe inclined toward left, dorsal apical hook not present (figs. 116a and b), spines of internal sac not acuminate apically, median portion of dorsal apical plate not scutellate medially.

Included species:

*Dicaelus costatus* Le Conte

## *Purpuratus* group

The distinguishing characteristics of this group are presented in the section dealing with the classification of the species of the subgenus *Dicaelus,* and its distribution is discussed below.

**Dicaelus** (*s. str.*) **purpuratus** Bonelli

Reasons are presented in the following discussion for combining *D. splendidus, D. quadratus,* and *D. darlingtoni* with *D. purpuratus* to form a single, polytypic species.

I am including *D. splendidus* Say in this species because this form differs from typical *purpuratus* in only two features, one of which is not absolute; in addition, the two forms are largely allopatric, their ranges overlapping only in the Mississippi Valley. Elytral color is the most distinctive feature, the elytra being coppery red or metallic green in *splendidus,* and purple or dull green in typical *purpuratus.* Color is usually not a character of specific value, since in other groups of organisms forms, which are otherwise identical, will differ strikingly in color.

The second diagnostic feature is that almost all individuals of *D. p. purpuratus* have the sixth abdominal sternite punctate to a varying degree (some from Ohio, Michigan, Indiana, and Illinois lack them completely), these punctures bearing very short hairs. On the other hand, almost all specimens of *D. p. splendidus* lack these punctures, with the exception of some from Missouri, Arkansas, Oklahoma, and Texas. Further, more females of *p. purpuratus* from the Atlantic coastal states have the 6th abdominal sternite densely punctate, and more females from the more central states have this sternite moderately to sparsely punctate. Thus this character apparently varies clinally, the cline not corresponding exactly with the distribution of color, so that a few

specimens which belong to these two subspecies may be interpreted as hybrids. It would seem, therefore, that *purpuratus* and *splendidus* may best be considered as geographical races of one species, rather than distinct species.

Reasons similar to those stated above are involved in treating *D. quadratus* and *D. darlingtoni* as geographical races of *D. purpuratus,* as these forms are largely allopatric and their diagnostic characters tend to merge toward the periphery of each subspecies, or, as in the case of *D. darlingtoni,* the diagnostic characters vary sufficiently to suggest an exchange of genetic material with its morphologically, as well as geographically, closest neighbor, *D. quadratus.*

The supposed relationship of *quadratus* to its more northern neighbor, *D. purpuratus,* is less certain than the relationship of *quadratus* to *darlingtoni,* or of *purpuratus* to *splendidus.* The pronotum, with the lateral declivity of the disc broadly interrupted by the confluence of the anterior discal with the posterior lateral impressions, elytra, with intervals 3 and 5 distinctly more convex and raised above intervals 1, 2, 4, and 6, and absence of setigerous punctures (other than the usual single row), distinguish *D. quadratus* from *D. purpuratus.* Specimens of both forms occur at Mobile, Alabama, and all that I have seen may be readily identified as one or the other of the two. No real intergrades are known to me, i.e. single specimens showing the diagnostic features of both forms. However, the pronota of the Gulf Coast specimens of *purpuratus* show a definite tendency in shape and in greater extent of the discal and posterior impressions (as compared with specimens from more northern localities), toward the condition seen in *D. quadratus.* The same is true to a slight degree for arrangement of the elytral intervals in Gulf Coast *purpuratus,* and many specimens of both *splendidus* and *purpuratus* have intervals 3 and 5 slightly more convex than 1, 2, 4, and 6, a fact which reduces the specific value of this character. Further, variation in relative width of the elytral intervals occurs in *D. furvus* and is at best only of value in defining subspecies in that species. This additional circumstantial evidence is slight, but it does seem to indicate that no very fundamental difference exists between specimens which differ in arrangement of the elytral intervals. Of the few specimens of *D. quadratus* that I have seen, none have abdominal sternite 6 punctate-hairy, and conversely, no specimens of *D. purpuratus* from

the Gulf Coast have this segment glabrous or even nearly so. Using this character as an indicator it could be pointed out that these two forms cannot or do not interbreed, assuming that the opportunity to do so is presented, and that therefore they are distinct species. I cannot refute this argument with the material at hand and submit it, therefore, as evidence against my position.

At least the differences between *D. purpuratus* and *D. quadratus* are less than the differences separating any other pair of related species in this genus, and if these two forms are in reality specifically distinct, they are the most closely related of any in the genus.

The solution of this problem lies in a careful study of the coastal plain populations of these two forms in the areas where they come together. Final determination of their taxonomic status can probably be made by observations which should be designed to answer the following questions. How do representatives of the two populations behave with regard to one another? What is the nature of the niche occupied by each form? What is the nature of the isolating mechanism which prevents complete panmixia in the area of overlap, and how effective is it, or is there such a mechanism? How are the diagnostic features determined—are they inherited independently, or are they closely linked and thus inherited as a unit? Are the immature stages of each form the same or different structurally, the same or different biologically?

To summarize this discussion, it would seem that the four largely allopatric forms included in this species can be arranged in two groups on the basis of morphological similarities and dissimilarities: one including *D. purpuratus* and *D. splendidus*; the other, *D. quadratus* and *D. darlingtoni.* The term exerge, used by Verity (1926: 193) to designate a well-marked group of subspecies within a polytypic species, is used for each of these groups.

If future work demonstrates that I have "lumped" too extensively, the species *purpuratus* may be considered a superspecies (*sensu* Mayr: 1942) composed probably of two, or possibly three (*splendidus* presumably could be specifically distinct), slightly differentiated species.

The diagnostic features of this species are indicated in the key.

The range of *Dicaelus purpuratus,* a polytypic species, is the eastern coast of North America from Massachusetts to southern Florida, in the Appalachian Mountains to at least 4000 feet altitude; westward to

southern Minnesota in the north, Colorado in the middle west, Arizona in the southwest, and the Rio Grande Valley in southeastern Texas.

The four subspecies of *Dicaelus purpuratus* may be divided into two groups which are distinguished on the basis of differences in the pronotal disc and in the relative convexity of elytral intervals 3 and 5.

exerge *purpuratus*

The two races of this subspecies group exhibit the following characters in common: elytral intervals 2-6 all of approximately the same degree of convexity, and the lateral declivity of the pronotal disc not broadly interrupted by the confluence of the anterior discal impressions with the posterior lateral impressions. (This latter character shows indications of breaking down in specimens from Mobile, Alabama.)

The two subspecies included in this group exhibit reverse geographical trends in rugosity of the head and pronotum. Specimens of *D. p. purpuratus* from the southern part of the range have these structures appreciably more rugose, on the average, than specimens from the more northern areas. The opposite is true of *D. p. splendidus,* for specimens from the extreme southern part of the range of distribution, as it is known at present, have the head and pronotum appreciably smoother than more northern individuals.

Members of this exerge are found throughout the species range outlined above, excluding peninsular Florida and possibly the panhandle as well.

**Dicaelus purpuratus purpuratus** Bonelli

*Dicaelus purpuratus* Bonelli, 1813: 447; [type a female for which no locality is indicated].—Dejean, 1826: 385.—Le Conte, 1853: 388.—Chapuis and Candeze, 1853: 375.—Zimmerman, 1868: 246; (1868).—Horn, 1880: 51-52; (1880).—Dimmock and Knab, 1904: 21-30, pls. 1-2.

*Dicaelus violaceus* Bonelli, 1813: 447. Type locality: Carolina; (specimen collected by Bosc.).—Dejean, 1831.—Le Conte, 1848: 424.—Laferté, 1851: 276.—Le Conte, 1853.—Horn, 1880.

*Dicaelus chalybeus* Dejean, 1826: 385. Type locality: Louisiana.—Dejean, 1831.—Le Conte, 1848.—Laferté, 1851: 276.—Le Conte, 1853.—Horn, 1880.

*Dicaelus cyaneus* Dejean, 1831: 686. Type locality: *Amer. sept.;* (type specimen received from M. Le Conte).—Le Conte, 1848: 425.—Laferté, 1851: 276.—Le Conte, 1853.—Horn, 1880.

*Dicaelus confusus* Le Conte, 1848:424; [type specimen a female from "Georgia"; in Le Conte Coll. no. 5711].—Le Conte, 1853.—Horn, 1880.

*Dicaelus iricolor* Le Conte, 1848:426; [type specimen a male, collected at St. Louis Mo.; in Le Conte Coll. no. 5712].—Le Conte, 1853.—Horn, 1880.

The western limits of distribution of *D. p. purpuratus* seem to be formed principally by the Mississippi Valley, but I have seen a single specimen from "Texas" and one labelled "Mo." Otherwise all specimens which I have examined are from localities east of the Mississippi River. To the north this subspecies ranges into southern Michigan, north to Berrien County, is known to occur along the southern shore of Lake Erie, but is known from New York State, only from Long Island and Staten Island in the east, and extends northward to "Mass.", presumably close to the Atlantic Coast. Southward, the range of *D. p. purpuratus* contacts that of *D. p. quadratus* along the eastern Gulf Coast.

*Synonymical Notes.*—The synonyms of *D. purpuratus* are all based upon specimens which differ from one another only in color, a character which seems to vary individually and not geographically. I feel, therefore, that the synonomy presented by Horn in 1880, and which is reproduced above, is correct.

*Variation.*—The following features vary intra-subspecifically: color, pronotal sculpture, pronotal shape, punctation of abdominal sternite 6, and size.

Total length—males, 20.6-25.0 mm. (22.8 mm.); females, 20.7-24.7 mm. (23.2 mm.). Maximum width—males, 9.0-10.5 mm. (9.5 mm); females, 9.3-11.1 mm. (10.0 mm.). Samples of specimens from the Gulf Coast average larger than those from further north. On the whole, the color of the dorsal surface of this subspecies is a rich dark purple varying to bright violaceous, metallic blue, and in the elytra in a few specimens to a dull metallic green. This latter condition is exhibited by the following specimens: one female, Wayne County, and one female, Berrien Co., Mich.; one male, Lafayette, Ind.; one male, Tippecanoe Co., Ind.; one female, Chicago, and one male from Oregon, Ill. A single female from Mobile has an entirely black dorsal surface.

Pronotal sculpture varies approximately with size, large specimens with the dorsal surface rather strongly rugose, smaller specimens, especially from the northeast, with the pronotal surface only rugulose and with the median portion of the disc approximately smooth.

The conformation of the lateral margins of the pronotum varies from approximately parallel, through narrowly arcuate, to broadly arcuate; from slightly incurved anteriorly to strongly incurved posteriorly; from more or less straight, to slightly sinuate. A majority of specimens from the northern part of the range (90 percent) have a moderately convex disc, but a few specimens have the disc flattened medially. Specimens with the convex disc usually have small to moderate sized discal impressions which do not interrupt the curvature of the disc laterally. Specimens exhibiting a more flattened disc also have more extensive impressions which either may or may not interrupt the lateral declivity. All seven specimens of this subspecies which I have seen from Mobile, Alabama have the latter type of pronotum, in which the lateral declivity is shallowly interrupted by the posterior extension of the lateral discal impressions. (See table 38 for a detailed analysis of variability of the diagnostic features in the Mobile, Alabama specimens).

Elytral intervals 3 and 5 are slightly more convex in a few specimens from localities scattered throughout the range of this subspecies.

Females usually have relatively more accessory punctures on the 6th abdominal sternite than the males, and, further, more females from the more eastern localities have relatively more punctures than individuals from the more westerly localities. More specimens, both males and females, from the North Central States completely lack accessory setae, and their punctures, than specimens from east coast localities. Presence or absence of accessory punctures and their relative abundance seems to vary continuously in an east-west direction. Further, since absence of the accessory setigerous punctures seems to be a characteristic of *D. p. splendidus,* those specimens which have purple elytra but lack the accessory punctures may be thought of as intergrades between *splendidus* and typical *purpuratus.*

Biology.—Dr. A. B. Champlain has informed me that he has observed specimens of this subspecies feeding on snails. Dimmock and Knab (1904: 30) have published a description of the habits and life history of *Dicaelus purpuratus* and report having observed an adult feeding on the snail *Tropidopsis tridentata* Say.

*Distribution.*—I have seen one hundred eighteen males and eighty-seven females collected in the following states.

Southern and western peripheral localities—Alabama: Mobile County, Mobile. Texas: "Texas." Illinois: Knox County; Galesburg. Wisconsin: Chippewa County; Stanley. Additional states—Connecticut. District of Columbia. Georgia. Indiana. Kentucky. Louisiana. Maryland. Massachusetts. Michigan. Mississippi. New Jersey. New York. North Carolina. Ohio. Pennsylvania. South Carolina. Tennessee. Virginia. West Virginia.

**Dicaelus purpuratus splendidus** Say, new combination

*Dicaelus splendidus* Say, 1825: 69; [type specimen "brought from the upper Missouri by Mr. Thomas Nuttall."].—Ibid., 1825: Pl. 24, fig. 1; [specimen figured; in color: a female].—Le Conte, 1848: 423-424.—Ibid., 1853: 388.—Wickham, 1893: 195-199, Pl. I.—Fall, 1932: 20.

*Dicaelus decoloratus* Le Conte, 1848: 423; [type specimen a female from Texas, collected by Dr. Engelman; in Le Conte Coll. no. 5710.].—Ibid., 1853: 388.—Horn, 1880: 52.

*Dicaelus speciosus* Casey, 1913: 152; [type specimen a male from New Mexico, in Casey Coll.].—Fall, 1932: 20.

The principal diagnostic feature of this subspecies is elytral color which varies from iridescent reddish-coppery to metallic green. In addition, in 78% of the specimens which I have examined, the 6th abdominal sternite has only a single row of 4-8 setigerous punctures.

Primarily a Great Plains race, *D. p. splendidus* ranges northward into Minnesota, eastward into Illinois and Louisiana, southward to the Rio Grande Valley, westward to the Rocky Mountains, and southward to southeastern Arizona. I have seen a single specimen of this subspecies labelled "Paterson, New Jersey," but question the accuracy of this record.

*Variation.*—The following features vary intra-subspecifically: size, color, pronotal shape and sculpture, convexity of elytral intervals, and punctation of the 6th abdominal sternite.

Total length—Males, 18.6-25.7 mm. (22.2 mm.); females, 19.4-26.2 mm. (23.5). Maximum width—males, 8.7-11.2 mm. (9.7 mm.); females, 9.0-11.8 mm. (10.5 mm.). Size seems to vary continuously with southern samples, on the average, slightly larger than those from farther north.

In specimens from southern Texas, the violaceous color of the pro-

notum is restricted more or less to the lateral margins, the greater area of the pronotum, therefore, being black. In specimens from more northern localities, coloring extends to the lateral discal and posteriolateral impressions. Usually the elytra are a bright coppery red, varying to more brassy, to greenish, greenish color occurring in about 50% of the Iowa specimens studied, the more brassy lustre and less intense color characterizing the specimens from southern Texas.

The head is smoother than average in specimens from southern Texas but not smoother than all specimens from more northern localities.

The lateral margins of the pronotum are typically moderately incurved anteriorly, rather moderately arcuate medially, and approximately straight and parallel to one another posteriorly. They vary to slightly arcuate and slightly incurved anteriorly, and posteriorly to slightly incurved and sinuate. The pronotal discs of three specimens from southern Texas are smoother than average.

The elytral surface is typically very finely alutaceous, the cells formed by the short lines varying in size, overlain by short, transverse, shallow markings. Two males from the Jemez Mountains, N. M. have the short transverse markings deeper than usual, with the fine underlying network barely perceptible at a magnification of 54 dia.

As was noted above, specimens from southern Texas (Austin to Kingsville, 5 males and 10 females) differ in several features from specimens which were collected in more northern localities. These differences may be of subspecific value but I do not think so because the characters are sufficiently variable so that one specimen, from Kingsville, is more like typical *splendidus* than like its closest neighbors.

*Synonymical Note.*—The type specimen of *decoloratus* Le C. was said to be nothing but a badly colored specimen of *splendidus.* However, I examined the specimen labelled as type in the Le Conte collection, and its coloring appeared perfectly normal to me. It is possible, therefore, that the specimen labelled as such is really not the type. Casey's species, *speciosus,* is based on a smaller than average male from New Mexico, and Fall was correct when he recognized it as a synonym of *splendidus.*

*Distribution.*—I have examined one hundred ten males, and one hundred four females collected in the following localities.

Peripheral localities—"MINNESOTA." IOWA: Des Moines County. MISSOURI: St. Louis County; St. Louis. LOUISIANA: Camp Polk. TEXAS: Kleburg County; Kingsville. ARIZONA: Graham County; Camp Grant. Additional states—ARKANSAS. COLORADO. KANSAS. NEW JERSEY [see discussion of distribution above]. NEW MEXICO. OKLAHOMA.

exerge *quadratus*

The two races of this subspecies group may be distinguished from the members of exerge *purpuratus* by the following characters: lateral declivity of the pronotal disc broadly interrupted by the confluence of the anterior discal impressions with the posterior lateral impressions; elytral intervals 3 and 5 distinctly more convex than intervals 1, 2, 4, and 6; head generally more rugose.

This group of subspecies ranges throughout peninsular Florida, excluding the off-shore Keys, northward to southern Georgia, and westward at least as far as Mobile, Alabama.

**Dicaelus purpuratus quadratus** Le Conte, new combination

*Dicaelus quadratus* Le Conte, 1848: 422; [type specimen a male, collected in "Georgia"; in Le Conte Coll., MCZ no. 5713].—Ibid., 1853: 388.

*Dicaelus Lecontei* Laferté, 1851: 277. Type locality: "Amer. bor."—Le Conte, 1853: 388.—Horn, 1880: 52.

The broadly arcuate sides of the pronotum and the dark purple color of the elytra and pronotal margins distinguish this subspecies from *p. darlingtoni.*

This subspecies is known from southern Alabama and Georgia, and northern Florida.

*Variation.*—I have seen ten specimens which represent this subspecies, including the type. Specimens no. 3 and no. 4 of *quadratus* in the Le Conte collection appear to be intermediate between this subspecies and the following one. Total length—males, 22.4-23.9 mm. (23.4 mm.); females, 23.1-23.9 mm. (23.5 mm.). Maximum width—males, 10.3-10.9 mm. (10.6 mm.); females, 11.0-11.1 mm. (11.05 mm.).

The pronotum varies from broadly to less broadly arcuate, and one specimen, from Mobile, Alabama has the pronotal sides shortly and abruptly constricted basally. See table 38 for comparison of the Mobile, Ala. specimens with specimens of the typical subspecies from the same locality.

*Distribution.*—In addition to the type and paratypes, I have examined three males and four females collected in the following localities.

ALABAMA: Mobile County; Mobile, Mt. Vernon. FLORIDA: Duval County; Jacksonville.

TABLE 38

VARIATION IN DIAGNOSTIC OR PARTIALLY DIAGNOSTIC CHARACTERS IN SPECIMENS OF *D. Purpuratus* AND *D. Quadratus* FROM MOBILE, ALABAMA.

| No. Specimens | Head Rugosity | Pronotum Type | Elytra Intervals | Ab. St. 6 Acc. Setae | Det. |
|---|---|---|---|---|---|
| 6 | dense | q[1] | alternate[4] | absent | quadratus |
| 1 | slight | p-q[2] | even | present | purpuratus |
| 1 | moderate | p-q | even | " | " |
| 1 | dense | p-q | " | " | " |
| 1 | moderate | p-q | " | " | " |
| 1 | dense | p[3] | alt. slight | " | " |
| 1 | dense | p-q | even | " | " |
| 1 | moderate | p | alt. slight | " | " |

Explanation of Abbreviations

[1] *quadratus*-type pronotal disc.
[2] disc intermediate between *quadratus* and *purpuratus* type.
[3] *purpuratus*-type pronotal disc.
[4] elytral intervals 3 and 5 distinctly more convex than 1, 2, 4, & 6.

**Dicaelus purpuratus darlingtoni** Fall, new combination

? *Dicaelus purpuratus* Horn, [in part], (not Bonelli), 1880: 52.
*Dicaelus quadratus* Leng, [in part], 1915: 580; [locality records: ? Cedar Keys; Biscayne Bay, (Schwarz); Fort Myers, March 6, (Blatchley)].
*Dicaelus darlingtoni* Fall, 1932: 19-20, [type specimen a female, (P. J. Darlington); in Fall collection, MCZ No. 23875]. Type locality: Homestead, Florida, (P. J. Darlington, Jr.); (determined from original description).

The narrowly rounded, posteriorly sinuate sides of the pronotum and the bright violaceous color of the dorsal surface will distinguish this subspecies from *p. quadratus.*

Described from Homestead, Dade County, Florida, *p. darlingtoni* is found in the southern three fourths of peninsular Florida. Specimens which are intermediate between *quadratus* and *darlingtoni* are known from various localities through this state.

*Variation.*—Total length—males, 20.3-24.1 mm. (22.2 mm.); females, 20.8-25.5 mm. (22.6 mm.). Maximum width—males, 9.3-10.3 mm. (9.7 mm.); females, 9.2-11.2 mm. (10.0 mm.). See table 39 for data on variation in color, head rugosity, pronotal shape, and relative degree of alternation of elytral intervals.

TABLE 39

VARIATION IN *Dicaelus p. darlingtoni.*

| Locality | No. of Specimens | Head Rugosity | Pronotum Shape | Elytra Intervals | Color |
|---|---|---|---|---|---|
| Gainesville | 1 | moderate | darl.[1] | alternate | violaceous |
| Cedar Keys | 1 | dense | darl. | alternate | dark[4] |
| " " | 1 | " | quad.-darl.[2] | " | " |
| Sanford | 1 | dense | darl. | " | violaceous |
| " | 1 | " | " | " | dark |
| St. Petersburg | 1 | " | " | " | int.[5] |
| Ft. Myers | 1 | moderate | quad.[3] | " | violaceous |
| Ft. Lauderdale | 1 | slight | darl. | " | " |
| Miami | 1 | dense | quad.-darl. | alternate | int. |
| Miami | 1 | " | " " | weakly alternate | dark |
| Homestead | 2 | moderate | darl. | weakly alternate | violaceous |
| " | 2 | dense | " | alternate | " |
| " | 1 | dense | quad.-darl. | " | dark |
| " | 6 | ?[6] | darl. | " | violaceous |
| Royal Palm Park | 5 | moderate | " | " | " |
| " " " | 3 | dense | " | " | " |
| " " " | 5 | " | quad.-darl. | " | " |
| Detroit | 7 | moderate | darl. | " | " |
| " | 2 | " | " | weakly alternate | " |

Explanation of Abbreviations

[1] darl.—sides of pronotum sinuate basally.

[2] quad.-darl.—sides of pronotum not sinuate basally, but not broadly rounded.

[3] quad.—sides of pronotum broadly rounded.

[4] dark—dark purple.

[5] int.—intermediate between violaceous and dark purple.

[6] ?—this character not studied in this specimen which is in the Museum of Comparative Zoology Collection.

If color and shape of the pronotum are regarded as the diagnostic features by which *quadratus* may be distinguished from *darlingtoni*, there are six out of forty-three specimens examined that show various combinations of these characters. This seems to indicate that *quadratus* and *darlingtoni* are two very closely related populations—probably good subspecies, certainly nothing more. A further point illus-

trated by an analysis of the variation within this subspecies is that the alternation of the elytral intervals is probably not of specific value in the *purpuratus* group as this character varies, slightly, within the Floridian populations.

*Distribution.*—Two specimens of this subspecies, collected by me in Myakka River State Park, Sarasota County, Florida, were found on rather dry soil, under dead palm fronds.

In addition to the type, I have seen nineteen males and twenty-one females collected in the following localities.

FLORIDA: "Fla." Alachua County; Gainesville. Broward County; Ft. Lauderdale. Dade County; Homestead, Miami Beach, Royal Palm St. Pk. Lee County; Ft. Myers. Levy County; Cedar Keys. Osceola County; Deer Park. Pinellas County; St. Petersburg. Seminole County; Sanford. County not determined; Detroit, Long Pine Key.

### *crenatus* group

The distinguishing characteristics of this species group are presented in the section dealing with the classification of the species of the typical subgenus.

Members of the *crenatus* group range from southern Florida and the Gulf Coast westward in Texas to at least Gatesville (probably to the 100th Meridian), southward at least to Victoria (probably into Mexico), and northward in the Mississippi Basin to southern Kansas.

The two species of which this group is composed are largely allopatric with the ditypic *alternans* confined to Florida and the eastern portion of the Gulf Coast, *crenatus* ranging into the Mississippi Basin and eastward in the Gulf Coastal states to western Georgia, but their ranges may very well overlap in northern Florida and southeastern Alabama as well.

**Dicaelus** (*s. str.*) **crenatus** Le Conte

*Dicaelus crenatus* Le Conte, 1853: 389; [type specimen a female, labelled with an orange disc, in Le Conte Coll., MCZ no. 5714].—Type locality: Louisiana; (determined from original description).

The disc of the pronotum of this species is flat, and not more or less convex as it is in *Dicaelus alternans.* The members of this species average smaller in size than do the specimens of *a. alternans* but are of about the same size as *a. subtropicus.*

*Variation.*—Data on variation in the following mensural characters and ratios are presented in tables 40-42—length, width, El: W int. 5/ W int. 4. The surface is usually glossy, varying to opaque. There is slight variation in distinctness of lines of macrosculpture. The labrum tends to be more quadrate, on the average, than in *D. costatus,* and the anterior margin exhibits slight variation in the depth of the anterior emargination; the median longitudinal impression is usually shallow, slightly deeper anteriorly than posteriorly, and obsolescent in a few specimens. The pronotum is as in fig. 100. Size of elytral punctures varies slightly, but in all specimens the punctures are easily discernable with the aid of the low power of a binocular microscope (6×). There is slight variation in the length and shape of the frontal impressions of the head and pronotal impressions. The median lobe of the male is as in figs. 114a and b. Eighteen males were dissected. Setigerous punctures on the 6th abdominal sternite vary as follows—males, 4-6 (4.4); females, 6-8 (6.9).

*Distribution.*—This species ranges through the Gulf coastal states, westward probably to the 100th Meridian, southward probably into Mexico, and northward in the Mississippi Basin to southern Missouri. I have not seen material that will verify the following records: Löding (1945: 18) records *crenatus* as occurring "over State" of Alabama, from June to October; Notman (in Leonard, 1926: 229) records this species from Buffalo, New York. (I believe this record is based on either an incorrectly labelled specimen or on a misdetermination.); Fattig (1949: 31) records *crenatus* from Gainesville and Summerville, Georgia; Brimley (1938: 122) records this species for Southern Pines, North Carolina.

I have seen eighteen males and eighteen females collected in the following localities.

MISSOURI: Carter County; Van Buren. ARKANSAS: Hempstead County; Southwest. KANSAS: "Kan." OKLAHOMA: "I. T." [Indian Territory?]. TEXAS: Cook County; Gainesville. Coryell County; Gatesville. Dallas County; Dallas. Travis County; Austin. Victoria County; Victoria.

**Dicaelus** (*s. str.*) **alternans** Dejean

In addition to the characters presented in the key, the disc of the pronotum of *alternans* is more convex than is that of the preceding species.

This species is here regarded as being ditypic, composed of the nomotypical subspecies, and *a. subtropicus* Casey. These two forms are identical with respect to structure of the male genitalia. Both have the same type of pronotum and both have short setae scattered over the surface of the elytra, a characteristic peculiar to them in the genus *Dicaelus*. They differ in that *alternans* is larger in size (see tables 40-41) on the average, with elytral intervals 3 and 5 more convex, appreciably wider (see table 42), more opaque, with more setae scattered over the surface. *Subtropicus* averages smaller in size, with elytral intervals all of about the same convexity, 3 and 5 wider than 1, 2, 4, and 6, but not as much as the typical subspecies, and the former are not more opaque, and have only a very few or no setae on their surface. In addition to the morphological data which seem to indicate a close alliance between them, *alternans* and *subtropicus* are allopatric. Specimens of *alternans* are not known from south of the southern tip of Lake Okeechobee, in Florida, and, conversely, specimens of *subtropicus* have been found only in localities which are south of the latitude of Lake Okeechobee.

**Dicaelus alternans alternans** Dejean

*Dicaelus alternans* Dejean, 1826:387, [type specimen in Oberthür Coll., (fide Lindroth)]. Type locality: "Amerique septentrionale"; [probably southern Georgia, as the type specimen was received from Le Conte].

The diagnostic features of this subspecies are presented in the key and in the preceding discussion.

*Variation.*—Data on variation in the following mensural characters and ratios are presented in tables 40-42—length, width, El: W int. 5/W int. 4. Surface lustre is usually subopaque but is glossy in four specimens from Naples and one from Orlando County. The terminal segment of the labial palpus varies from moderately to broadly triangular, the truncate apical margin either subequal in length to or distinctly shorter than the inner margin. The pronotum is beaded laterally, anteriorly from 1/3 to 3/4 of its length, average condition lying between 1/2 and 2/3. The posterior lateral impressions, deeper on the average than in *crenatus,* exhibit slight variation in depth and length. The microsculpture of intervals 3, 5, and 7 is finer than that of the other intervals, and the former are more glossy than the latter. In-

tervals 1, 3, 5, and 7 always bear small setigerous punctures but fewer than on the remaining intervals. Strial punctures are large enough to be easily seen in twenty-two specimens, small enough to be easily overlooked or absent in thirteen specimens. Setigerous punctures on the 6th abdominal sternite vary as follows: males, 4-6 (4.6); females 6-10 (7.3).

The median lobes (fig. 115a) of fourteen males exhibit slight variation in shape of the apical portion. All are about the same as in figs. 115a and b and are clearly distinct from *D. crenatus.* The internal sac is as in fig. 115b (one spine not shown).

The styli of the female retractile plates in three specimens are relatively short and broad, the length of the blade not exceeding that of the coxite.

*Distribution.*—This species ranges from southeastern Georgia southward to Fort Myers, Florida. Brimley (1938: 122) records *alternans* from Southern Pines. I suspect that this record may be based on a misidentified specimen of *D. f. carinatus,* a form which superficially resembles *alternans* and which should occur at Southern Pines.

I have seen fourteen males and two females collected in the following localities:

GEORGIA: Glynn County; St. Simon Island. FLORIDA: "Fla." Alachua County; Gainesville. Charlotte County; Punta Gorda. "Citrus County." Collier County; Naples. "Dixie County." Glades County; 2 mi. s. of Palmdale. Lee County; Fort Myers. Manatee County; Bradenton, Palmetto Key. "Marion County." Pinellas County; Dunedin. County undetermined; Ortego, Lake Harney.

**Dicaelus alternans subtropicus** Casey, new combination

*Dicaelus subtropicus* Casey, 1913: 151; (Type specimen a male, labelled "Fla.," in Casey Coll., USNM no. 47358). Type locality: Palm Beach, Florida (Kinzel); (determined from original description).
*Dicaelus alternans* Leng, 1915: 580.

The distinguishing characteristics of this subspecies are given in the Key and in conjunction with the diagnostic features of the typical subspecies, *D. a. alternans.* In some ways *subtropicus* is more similar to *crenatus* than it is to *alternans.* The two forms are both of about the same size and are almost identical with respect to elytral characters.

However, all specimens of *subtropicus* have at least a few setae on intervals 1, 2, 4, and 6, and the strial punctures are either smaller than in *D. crenatus* or lacking altogether.

*Variation.*—Data on variation in the following mensural characters and ratios are presented in tables 40-42—length, width, El: W int. 5/W int. 4. Variation in lustre and macrosculpture is about the same as in the typical subspecies. Elytral intervals 3 and 5 are on the average slightly wider than 1, 2, 4, and 6. Intervals 1, 3, 5, and 7 are sparsely punctate as in the typical subspecies. Variation in size of strial punctures is considerable, from somewhat smaller than in *D. crenatus* (4 specimens), to absent or at least difficult to see (8 specimens). Intervals 4, 6, and 8 are not punctate, nor is the microsculpture coarser than in intervals 1, 3, 5, and 7.

The median lobes of eight males exhibit slight variation in shape of the apical margin. The female retractile plates of 3 females are about the same as those of the typical subspecies.

*Distribution.*—This subspecies is known from a few localities in the southern 1/3 of Florida, and at Key West.

In addition to the type series I have seen nine males and three females collected in the following localities.

FLORIDA: Dade County; Biscayne Bay, Miami, Royal Palm Park. Monroe County; Key West.

### *costatus* group

The distinguishing characteristics of this species group are presented in the section dealing with the classification of the species of the subgenus *Dicaelus*.

TABLE 40

*Crenatus* species group: VARIATION IN TOTAL LENGTH (MM.).

| Species | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | N | Range | Mean | N | Range | Mean |
| *crenatus* ..... | 18 | 13.6–18.0 | 15.8 | 18 | 13.0–17.6 | 15.8 |
| *a. alternans* ..... | 14 | 15.3–20.0 | 17.8 | 21 | 13.7–21.3 | 17.5 |
| *a. subtropicus* .... | 13 | 13.8–16.5 | 15.2 | 5 | 13.9–16.9 | 15.2 |

TABLE 41

*Crenatus* species group: Variation in Maximum Width (mm.).

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *crenatus* ..... | 18 | 5.6–7.5 | 6.6 | 18 | 5.4–7.7 | 6.7 |
| *a. alternans* ..... | 14 | 6.3–8.5 | 7.6 | 21 | 6.0–9.2 | 7.6 |
| *a. subtropicus* .... | 13 | 5.5–6.7 | 6.2 | 5 | 6.0–7.3 | 6.5 |

TABLE 42

*Crenatus* species group: Variation in Ratio El: W int. 5/W int. 4.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *crenatus* ..... | 18 | 0.95–1.40 | 1.18 | 18 | 0.84–1.37 | 1.13 |
| *a. alternans* ..... | 14 | 1.05–1.50 | 1.28 | 21 | 1.00–1.62 | 1.24 |
| *a. subtropicus* .... | 9 | 1.06–1.40 | 1.20 | 4 | 1.00–1.33 | 1.15 |

The distribution of the single component of this group, *D. costatus,* is presented below in the section dealing with that subject.

**Dicaelus** (*s. str.*) **costatus** Le Conte

*Dicaelus costatus* Le Conte, 1853:389; [type specimen a female, labelled "Tex.", in Le Conte Coll. MCZ no. 5708]. Type locality: "Texas"; (determined from original description, and label on type specimen).

*Dicaelus costatus* var. *lerdoensis* Bates, 1891:238. Type locality: Villa Lerdo, Durango, Mexico (Höge); (determined from original description).

The diagnostic features of this species are in the keys and in the characterization of the *costatus* group.

In the original description of this species Le Conte stated the opinion that *D. costatus* was most closely related to *D. dilatatus* and *D. dejeani,* but it is probably closer to *crenatus* and *purpuratus* than to any other species, and really not very close to those, either.

*Variation.*—Variation in length and width of a composite sample is as follows: 28 males, length 21.8-29.3 mm. (23.5 mm.), width 9.5-12.5 mm. (10.8 mm.); 22 females, length 20.6-27.5 mm. (23.3 mm.), width 9.2-12.0 mm. (10.7 mm.). However, size variation is apparently geographical, as is indicated in table 43, with specimens from the north averaging smaller in size than those from farther south. (The central Texas sample includes specimens from Dallas, McLennon, Bexar, Uvalde, and Val Verde counties, and the southern Texas sam-

ple includes specimens from Kleburg and Hidalgo counties.) A single male, collected at Gainesville, Florida, measures 25.2 mm. in length, thus coming closer in size to the southern Texas specimens than to those from central Texas.

The subocular striae vary from obsolescent to very fine and on the pronotum the transverse lines are generally obsolescent to obsolete. The sides of the pronotum (fig. 101) vary from strongly to moderately strongly incurved anteriorly in the Texas specimens. The three specimens from Mexico have the sides of the pronotum moderately incurved anteriorly. The single male collected in Florida has the sides more strongly arcuate and more constricted basally than any of the other specimens studied by me. The posterior transverse impression varies from moderately to very deep, and the median transverse from shallow to moderately deep. The transverse grooves of the abdominal sternites vary from moderately to very deep. The median lobe is as in figs. 116a and b. The number of setigerous punctures on the posterior margin of the 6th sternite varies from 2 to 10 (6.3) in the males and from 8 to 13 (10.4) in the females. Of twenty-three females examined twelve have a pair of ambulatory setae on the 6th sternite and 11 lack them (the latter condition is normal for the genus). These setae are not present on any of the males examined. The presence of an extra pair of setae in one sex only may possibly be the result of a mutation whose expression is sex-linked or sex-limited. The apical portion of the median lobe (fig. 116a) of the male genitalia varies slightly, but taxonomically insignificantly, in shape (23 specimens examined). The apex of the styli of the female retractile plates vary from acute to narrowly rounded, and the shaft varies slightly in width at base in the four specimens studied for this character.

*Synonymical Notes.*—I am provisionally including *lerdoensis* Bates and *costatus* under the same name because they differ only in size, which probably varies more or less clinically.

*Distribution.*—This species ranges from southern Tamaulipas and Durango, probably at relatively low elevations, northward to eastern Texas and eastward to northern Florida, probably via the Gulf Coast, and possibly northward on the Atlantic Coast to Virginia. I have seen only single specimens from Florida and Virginia. The Florida record

seems probable to me in the light of the known distribution pattern of *costatus,* but I seriously doubt the Virginia record.

I have collected a single specimen of *D. costatus* in a scrub oak area about 10 yards from the Nueces River, near Cotulla, Texas.

Forty-three males and thirty-three females collected in the following localities have been examined.

VIRGINIA: "Va." FLORIDA: Alachua County; Gainesville. TEXAS: "Texas." Bexar County; Macedona, San Antonio. Dallas County; Dallas. Hidalgo County; Edinburg, Mission. Kleburg County; Kingsville. La Salle County; Nueces River, near Cotulla. McLennon County; Waco. Uvalde County; Uvalde. Val Verde County; Devil's River. NUEVO LEON: S.[abinas] Hidalgo. TAMAULIPAS: 45 mi. E. of Mante (dense scrub area).

### Subgenus **Liodicaelus** Casey

*Liodicaelus* Casey, Mem. Col., Vol. IV, p. 154, 1913; (included species: *D. evanescens* Csy., *suffusus* Csy., *D. laevipennis* Le Conte and *D. flohri* Bates).

GENOTYPE: *Liodicaelus evanescens* Casey, 1913; (original designation).

The diagnostic features of *Liodicaelus* are indicated in the key and in the discussion of subgeneric classification.

TABLE 43

*Dicaelus costatus:* VARIATION IN TOTAL LENGTH (MM.).

| Locality | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| E. Cent. Texas ... | 18 | 21.6–24.9 | 23.2 ± 0.23 | 0.98 ± 0.16 | 4.2 |
| S.E. Texas ..... | 7 | 22.3–27.1 | 25.2 | | |
| Nuevo Leon ..... | 1 | 29.3 | | | |
| Tamaulipas ..... | 1 | 28.0 | | | |
| | | Females | | | |
| E. Cent. Texas ... | 20 | 20.6–24.3 | 23.0 ± 0.23 | 1.03 ± 0.16 | 4.5 |
| S.E. Texas ..... | 1 | 26.6 | | | |
| Tamaulipas ..... | 1 | 27.5 | | | |

Chiefly southwestern in distribution, the members of this subgenus range on the Mexican plateau southward as far as the latitude of Mexico City, and northward to Manyberries, Alberta. In altitude, species of this subgenus range from at least 9300′ at El Salto, Durago to almost sea level at Edinburg, Texas.

The species of *Liodicaelus* are all quite similar to one another so they are considered as belonging to a single group.
Included species:

*D. l. laevipennis* Le Conte
*D. l. dicaeloides* n. ssp.
*D. l. flohri* Bates
*D. l. abbreviatus* Bates
*D. chermocki* n. sp.
*D. suffusus* Casey

*Key to the Species and Subspecies of Subgenus Liodicaelus*

1. Elytral interval 7 not carinate, or very weakly and broadly so, El: L/W 1.30-1.36 ..... *D. l. abbreviatus* Bates
   Elytral interval 7 sharply carinate basally, El: L/W 1.35-1.55 ..... 2
2. PN: L/W base .91-1.09, eyes less convex than average for genus, punctures of elytral striae very small, length 18.6 mm. or more *D. chermocki* n. sp.
   PN: L/W base 1.13 or greater, eyes of average convexity, strial punctures of various sizes, or completely absent ..... 3
3. Maximum width less than 7.0 mm., length less than 18.9 mm., PN: W base/W apex less than 1.89, posterior margin of clypeus more or less angulate medially ..... *D. suffusus* Csy.
   Maximum width 7.00 mm. or more, length greater than 16.2 mm., PN: W base/W apex greater than 1.68, posterior margin of clypeus truncate medially ..... 4
4. First three or fewer discal elytral striae indicated by a row of punctures, rest of elytra smooth (or punctures weakly indicated) *D. l. flohri* Bates
   Elytral striae all clearly indicated by a row of punctures, lateral margins purplish or not ..... 5
5. Left mandible with basal portion molariform ..... *D. l. dicaeloides* n. ssp.
   Left mandible with basal portion not molariform *D. l. laevipennis* Le Conte

**Dicaelus (Liodicaelus) laevipennis** Le Conte

The diagnostic features of this species are in the key.

The most widely distributed species of the genus, *Dicaelus laevipennis,* ranges from Manyberries, Alberta in the north to Toluca, Mexico in the south, and from at least 9300′ in altitude on the Mexican plateau to almost sea level in southeastern Texas.

This species is composed of a number of morphologically distinct populations which are treated here as subspecies.

**Dicaelus laevipennis laevipennis** Le Conte

*Dicaelus laevipennis* Le Conte, 1848: 421; [type specimen a male, in Le Conte Coll., MCZ no. 5707]. Type locality: Chimney Rock, Platte River Valley, [Colorado]; (determined from original description; type specimen labelled with a blue disc—Nebraska & C).—Bates, 1884: 269.—Ibid., 1891: 239.

*Liodicaelus laevipennis* Casey, 1913: 155.

*Liodicaelus laevicollis* Casey, ibid.; [*lapsus calumae* for *D. laevipennis* Le Conte].

*Liodicaelus evanescens* Casey, ibid., p. 154; **New synonymy;** [type specimen a male, in Casey Coll., USNM no. 47364]. Type locality: San Bernardino Ranch, Cochise County, Arizona. (F. H. Snow Coll.); (determined from original description).

The key distinguishes this subspecies from those to which it is morphologically most similar.

*Variation.*—See tables 44-49 for data on variation in the following mensural characters and ratios—length, maximum width, W Pn/W head, PN: L/W apex, PN: W base/W apex, El: L/W. Two specimens from southern Arizona, one from southwestern Texas, and one from Colorado have the integument more shining than is usual. All specimens are suffused, in varying degrees, with purple or metallic blue color along the lateral pronotal margins, including lateral grooves, lateral thoracic sclerites, dorso-lateral margins of elytra, and elytral epipleurae; frequently this color is not readily seen, but appears when the specimen is immersed in fluid. There are no significant variations in any of the features of the head; the labrum varies from shallowly to very shallowly emarginate anteriorly. The terminal segment of the maxillary palpus varies from narrowly to more broadly triangular. There is slight but insignificant variation in the shape of the pronotum (fig. 102); posterio-lateral impressions vary slightly in depth. The elytra of the females are apically more broadly rounded than are those of the males. The relative length of the carinate portion of interval 7 varies slightly, averaging about 1/3 the total length of the elytra. The 6th abdominal sternite bears 3-7 (4.4) setigerous punctures in the males and 6-9 (7.3) in the females.

The median lobe of the male genitalia (figs. 117a and b) exhibits slight variation in the length and degree of constriction of the apical portion. Spines of the internal sac vary slightly in length and shape. One specimen labelled " N. M." has five spines, the remaining fifteen specimens having 6 spines.

*Synonymical Notes.*—The name *Liodicaelus evanescens* Casey was proposed for an Arizona specimen. This and others similar to it from southern Arizona (near Douglas) differ from the type of *laevipennis* Le Conte only in that the integument is more shining with no apparent indication of violaceous color on the lateral margins (but color can be seen if the specimen is immersed in fluid) and the body appears to be more slender and elongate. I did not dissect the type specimen of *evanescens,* but the genitalia of the southern Arizona males in my collection are like those of specimens which resemble the type of *laevipennis* in external characters. The luster of the integument and apparent narrowness of the body are quite variable features and a continuous series of variation from *laevipennis* to *evanescens* can be assembled. So it is reasonable to suppose that these two forms are not specifically distinct from one another. The southern Arizona specimens, or population(s) represented by them, may be subspecifically distinct from the more northern and typical *laevipennis* populations but I doubt this because one of the specimens from "Colorado," apparently well within the range of typical *laevipennis,* has the integument almost as shining as *evanescens,* and the integument of one specimen from Douglas, Arizona is almost as "dull" as is that of typical *laevipennis.* (Actually, specimens of typical *laevipennis* have a shining integument, but not as strongly so as that of *evanescens,* and with a different quality.) A large female from Alpine, Texas with a shining integument like that of *evanescens* is as similar to *laevipennis* as it is to *evanescens.* (I propose that this name be listed as a synonym of *D. laevipennis laevipennis* because the characters which appear to be diagnostic of *evanescens* are not constant geographically.) The more shining integument of the southern Arizona-southern Texas specimens is suggestive of that of *D. l. flohri,* and the single female from Alpine, Texas exhibits elytra with smaller than average punctures, and striae 4, 5, 6, and 7 are obsolete apically.

*Distribution.*—This subspecies ranges from southeastern Texas and Arizona northward to southeastern Alberta, to the east of the Rocky Mountains.

I have collected three specimens of this subspecies along the margin of an irrigated field six miles west of Douglas, Arizona. Sixteen males and ten females collected at the following localities have been examined.

ALBERTA: Manyberries. NEBRASKA: "Neb." KANSAS: "Ks." Hamilton County; Syracuse. COLORADO: "Col." El Paso County; Colorado Springs. Prowers County; Lamar. TEXAS: Brewster County; Alpine. Hidalgo County; Edinburg. NEW MEXICO: "N. M." Colfax County; Koehler, Maxwell. ARIZONA: Apache County; Springerville (8,000-8,100′ elev.). Cochise County; Douglas, 6 miles west of Douglas. MEXICO: "Mex."

**Dicaelus laevipennis dicaeloides,** new subspecies

Known only from two localities in the mountains of New Mexico, this subspecies may be distinguished from the typical one by the molariform condition of the basal portion of the left mandible. The name proposed for this subspecies alludes to the similarity in the basal area of the mandibles between this group of specimens and representatives of the typical subgenus. I have seen no intergrades between this form and the typical subspecies, but these two are regarded as being conspecific because of the many characters shared by them.

*Description.*—Type, male. Cloudcroft, Otero County, N.[ew] M.[exico], 9,000′, 26 July, 1948, (G. E. Ball), [Museum of Comparative Zoology Coll.].

Male. Length 17.4 mm., width 7.6 mm. Color as in typical subspecies, micro- and macrosculpture as in typical subspecies.

Head 2.06 times wider than long, frontal impressions broad, shallow, terminating posteriorly a short distance in front of anterior pair of supraorbital setigerous punctures. Left mandible differing from that of typical subspecies in that terebra is broadly concave, retinacular ridge and terebral tooth are lacking, basal margin behind basal terebral angle is broadly molariform, ventral groove in region of basal molar is about 1/2 a ventral groove hair's length from margin, right mandible differs only in that inner edge of terebral tooth is more worn. (See figs. 90a and b.) Terminal palpal segments as in typical subspecies. Eyes as in typical subspecies.

Pronotum 2.09 times wider than head, 1.53 times wider than long, 1.91 times wider at widest point than at apex, base as wide as widest point in front of it, 1.91 times wider at base than at apex, 1.25 times longer than wide at apex; shape and impressions about as in typical subspecies.

Elytra 1.10 times wider than pronotum, 1.47 times longer than wide, carinate portion of interval 7 0.27 the total length of elytra, similar to the typical subspecies in striae and intervals, apical portion narrowly rounded.

Venter as in typical subspecies, 6th sternite with six setigerous punctures.

Male genitalia: median lobe as in typical subspecies, internal sac with six spines.

Paratypes: 1 male, 8 females, same data for type; 1 female, Cloudcroft, N. M., VI.27.02, [Acad. Nat. Sci. Phila.]; 1 female, Cloud-

croft, N. M., 6/12/02, 7,000′, [Ks. St. Coll.]; 1 female, Cloudcroft, N. M. [Univ. Kan.]; 1 female Jemez Mts., N. M., V.30, Jno. Woodgate, [Cal. Acad. Sci.].

*Variation.*—All specimens are suffused in varying degrees with purple or metallic blue color on the sclerites and areas mentioned in description of typical subspecies. Macrosculpture exhibits about the same range of variation seen in the typical subspecies, the lines generally fine and faint. Length and depth of the frontal impressions vary slightly. The labrum exhibits slight variation in the extent and depth of the marginal emargination. The posterior margin of the clypeus varies from subtruncate to slightly arcuate, but not angulate medially. There is considerable variability in the terminal palpal segments but they are not broadly triangular.

See tables 44-49 for data on variation in the following mensural characters and ratios—length, maximum width, W pn/W head, PN: L/W apex, PN: W base/W apex, El: L/W.

Variation in the shape of the pronotum is slight, and the posteriolateral impressions vary slightly in depth.

The apex of the elytra is more broadly rounded in the females than in the males. Relative length of the carinate portion of interval 7 averages about 1/3 the total length of the elytra.

The 6th abdominal sternite bears 4-6 (5) setigerous punctures in the males, and 4-8 (7) setigerous punctures in the females.

The median lobe of the male genitalia is essentially as in the type with very slight variation. One specimen has five, instead of six, spines on the internal sac.

*Distribution.*—This subspecies has been taken at Jemez Springs, New Mexico as well as at the type locality. All specimens have been taken at or above 7,000′ elevation.

I have collected ten specimens at the type locality under rocks and rotten logs along the margin of a wet meadow, along with the salamander *Aeneides hardii* Taylor.

**Dicaelus laevipennis flohri** Bates

*Dicaelus flohri* Bates, 1878: 589. Type locality: San Angel, Distrito Federal, Mexico, (Flohr).—Ibid., 1882: 49.
*Dicaelus laevipennis flohri* Bates, 1884: 49.
*Liodicaelus flohri* Casey, 1913: 154.

This form may be distinguished from the other subspecies of *laevipennis* by the characters given in the key.

*Variation.*—Data on variation in the following mensural characters and ratios are presented in tables 44-49—length, maximum width, W pn/W head, PN: L/W apex, PN: W base/W apex, El: L/W.

There is slight variation in the punctures indicating elytral striae but they are shallower in all three specimens examined by me than in the typical subspecies. The two males have four setigerous punctures on the 6th abdominal sternite; the female, eight punctures.

*Distribution.*—This subspecies has been taken at Mexico City and Toluca, Mexico by Höge (Bates, 1891: 238) as well as at the type locality and San Felipe (the three specimens seen by me).

**Dicaelus laevipennis abbreviatus** Bates

*Dicaelus laevipennis* var. *abbreviatus* Bates, 1891: 239. Type locality: Refugio, Durango, Mexico; (determined from original description).

This broadly ovate subspecies is readily distinguished from the others by the absence of the elytral carina, the strongly convex elytra, the punctures which are very fine and obsolescent, and the left mandible which is like that of the typical subspecies.

In my opinion this form should be accorded specific status, it is so different in appearance from the other subspecies of *Dicaelus laevipennis.* However, Bates in the original description of *D. l. abbreviatus* stated that his series of specimens, from which the type was selected, included forms which are transitional in their characters between more typical specimens of *laevipennis* and this variety. As the known range of *abbreviatus* lies between the known ranges of *laevipennis* and *flohri,* the former subspecies must be altitudinally or ecologically separated from the range of the populations which connect the latter races and which are more similar to each other than either is to *abbreviatus.*

*Description.*—Male. J. Manuel, 9,300′, VI.3-8.1937, El Salto, Durango District, D[uran]go., Mex.[ico], (M. A. Embury), [California Academy of Science Coll.].

Length 15.2 mm., width 7.3 mm. Color as in typical subspecies (bluish color of margins apparent only when specimen is immersed in fluid). Integument shining. Micro- and macrosculpture as in typical subspecies, fine, to obsolescent.

Head 2.14 times wider than long, frontal impressions elongate shallow

basins terminating posteriorly a short distance in front of plane of anterior supraorbital setigerous punctures. Labrum with anterior margin shallowly incised, median longitudinal impression absent, but a median triangular depression present, its base along apical margin of labrum. Mandibles as in typical subspecies.

Pronotum in general facies as in typical subspecies, 2.10 times wider than head, 1.54 times wider than long, 1.85 times wider at widest point than at apex, 1.03 times wider at widest point than at base, 1.80 times wider at base than at apex; disc distinctly convex, moderately depressed posteriorly, sides strongly convergent anteriorly, almost parallel in posterior 1/2 but slightly divergent at base, anterior angles broadly rounded, anterior margin strongly concave; median longitudinal impression very shallow, posterior transverse impression obsolescent, posterior lateral impressions shallow basins.

Elytra 1.16 times wider than pronotum, 1.33 times longer than wide, evenly convex throughout, smooth, shining, each stria indicated by a row of obsolescent punctures, carina broadly and weakly indicated, obsolescent, apex more broadly rounded than average.

Abdominal sternites as in typical subspecies, 6th sternite posteriorly with a row of four setigerous punctures.

Male genitalia as in typical subspecies, internal sac with five spines.

*Variation.*—See tables 44-49 for data on variation in the following mensural characters and ratios—length, width, W pn/W head, PN: W base/W apex, PN: L/W apex, El: L/W.

There is slight variation in the size of the frontal impressions, depth of emargination of labrum, shape of the terminal palpal segments, and punctures on the elytra. Not any of the specimens seen in this study have the elytral punctures as deep as is the average condition for the typical subspecies.

The 6th abdominal sternite in the females bears 6-7 (6.1) setigerous punctures.

*Distribution.*—This subspecies is known only from Refugio, and El Salto, Durango, Mexico, at altitudes of 8,500-9,300′.

**Dicaelus (Liodicaelus) chermocki,** new species

This species is readily distinguished from other species of subgenus *Liodicaelus* by the following combination of characters: head wider than average with only slightly convex eyes, posterior margins of clypeus evenly rounded, pronotum less transverse than in *D. laevipennis* with the apex less narrowed and apical margin less deeply concave, the lateral margins posteriorly strongly sinuate, punctures indicating position of elytral striae obsolescent.

This species is named after my good friend and former teacher, Dr. Ralph L. Chermock, of the University of Alabama.

*Description.*—Type, female. Carr Canyon, Huachuca Mts., Cochise County, Ariz.[ona], 7,500′, 29 July, 1948, (G. E. Ball), [Museum of Comparative Zoology Coll.].

Female. Length 17.9 mm., width 8.2 mm. Integument generally black with a silky lustre, excepting piceous tarsi, palpi, and basal six segments of antennae; apical 5 segments of antennae are pale in color. Sculpture as in *D. laevipennis.*

Head 2.12 times wider than long, frontal impressions shallow, elongate, broad basins extending posteriorly beyond plane of anterior pair of supraorbital setigerous punctures and converging somewhat posteriorly. Labrum 1.72 times wider than long, 1.23 times wider at base than at apex, anterior margin moderately deeply incised, right lobe slightly longer than left, median longitudinal impression deep. Terminal segment of maxillary palpus with obliquely truncate apex, sides more or less parallel, hardly at all triangular in shape. Terminal segment of labial palpus narrowly triangular. Mandibles similar in general facies to those of *D. l. dicaeloides* (retinacular ridge lacking on left mandible but probably due to wear); terebral margin strongly concave, inner margin of basal portion with a well developed molariform area; right mandible typical for subgenus. Eyes slightly convex, not at all prominent.

Pronotum 1.66 times wider than head, 1.50 times wider than long, 1.58 times wider at widest point than at apex, disc slightly convex medially, moderately depressed posteriorly with relatively few, fine obsolescent, transversely directed lines, lateral margins rather strongly reflexed, separated from disc by broad groove on each side; sides evenly and more strongly convergent anteriorly than posteriorly, arcuate in anterior 1/2, broadly sinuate in posterior 1/2, anterior margin broadly and evenly concave, anterior angles narrow, lateral grooves each with the usual pair of setigerous punctures close to lateral margin; median longitudinal impression shallow, attaining neither basal nor apical margin; posterior transverse impression very weakly indicated, almost on same plane as posterior margin, connecting the shallow, broad, oblique posterior lateral impressions. (See fig. 103.)

Elytra 1.30 times wider than pronotum, 1.45 times longer than wide, each stria indicated by a row of small punctures which are barely evident laterally and apically but are larger and deeper medially and basally; carinate portion of interval 7 about 1/5 the length of the elytra; elytra broadly rounded apically, but not as broadly as in *D. l. abbreviatus.*

Abdominal sternites smooth medially, rugulose laterally, 6th abdominal sternite with a row of six setigerous punctures apically.

Paratypes, six, all females, have been taken in the following localities in ARIZONA. Cochise County; Huachuca Mountains, Sept. 3,

1931, L. K. Gloyd, [University of Mich. Mus. Zool.]; Ramsey Canyon, Huachuca Mountains, VI.7.20, J. R. Selvin, [Cal. Acad. Sci.]; Huachuca Mountains, VII.21.1912, J. R. Selvin, [Cal. Acad. Sci.]; Huachuca Mountains, [Amer. Mus. Nat. His.]; Chiracahua Mountains, [Acad. Nat. Sci. Phila.]. Tables 44-49 contain data on variation in the following mensural characters and ratios—length, maximum width, W pn/W head, PN: L/W apex, PN: W base/W apex, El: L/W.

*Variation.*—Color and lustre is the same as was described for the type, excepting one specimen, taken in Ramsey Canyon, which is more shining.

The frontal impressions and lines of macrosculpture of the head are deeper on the average than in the type. The pronotum is essentially as in the type with the sides either slightly more or less reflexed. The surface markings are as in the type but a little deeper in one specimen taken in Ramsey Canyon.

The elytra are as in the type.

The 6th abdominal sternite bears 6-7 (6.8) setigerous punctures near its posterior margin.

The male of this species is not known to me.

*Distribution.*—This species is known only from the Huachuca and Chiracahua Mountains of Arizona.

The type specimen was collected under a rock, near the margin of the small stream which flows through the upper end of Carr Canyon.

This species may possibly be only a montane race of *laevipennis,* but in the absence of geographically and morphologically intermediate forms, and because it is strikingly different from *laevipennis,* I have treated it as a distinct species.

**Dicaelus (Liodicaelus) suffusus** Casey

*Liodicaelus suffusus* Casey, 1913:155; [type specimen a male, in Casey Coll., USNM no. 47365]. Type locality: Sierra Madre Mountains of Chihuahua, Mexico; (determined from original description).

This species, the smallest of the subgenus *Liodicaelus,* may be distinguished from the other members of this group by the angulate posterior margin of the clypeus, normally convex eyes, left mandible without a molariform base (i.e. like that of *laevipennis*), elytra with deep punctures, and entire surface suffused with purple.

*Variation.*—This discussion is based on the type series and three additional specimens, the latter having been collected in the Chiracahua Mountains of southern Arizona.

See tables 44-49 for data on variation in the following mensural characters and ratios—length, maximum width, W pn/W head, PN: W base/W apex, PN: L/W apex, El: L/W.

The frontal impressions of the head are generally shallow and terminate posteriorly beyond plane of anterior pair of supraorbital setigerous punctures. There is very slight variation in fineness of lines of macrosculpture.

The pronotum is as in fig. 104. The posterior lateral impressions are feebly indicated laterally, not joined by the posterior transverse impression. The sides are arcuate anteriorly, feebly sinuate posteriorly, and either parallel or curving outward very slightly before almost rectangular posterior angles. The elytral striae are all about equally well indicated by punctures.

Setigerous punctures on the posterior margin of the 6th abdominal sternite vary as follow: 4-5 (4.1) in the males, and 6-7 (6.3) in the females.

Specimens included in the type series were not dissected. Male genitalia as in *laevipennis,* internal sac with five spines.

TABLE 44

Subgenus *Liodicaelus:* Variation in Total Length.

| Species | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| *l. laevipennis* ..... | 16 | 16.5–20.0 | 18.8 ± 0.20 | 0.80 ± 0.14 | 4.3 |
| *l. dicaeloides* ..... | 3 | 17.0–17.6 | 17.3 | | |
| *l. flohri* ..... | 2 | 18.7–20.5 | 19.6 | | |
| *l. abbreviatus* ..... | 1 | 15.2 | | | |
| *suffusus* ..... | 6 | 13.4–14.8 | 14.3 | | |
| | | Females | | | |
| *I. laevipennis* ..... | 9 | 17.2–19.0 | 18.4 ± 0.21 | 0.60 ± 0.15 | 3.3 |
| *l. dicaeloides* ..... | 11 | 17.1–19.1 | 18.0 ± 0.18 | 0.58 ± 0.13 | 3.2 |
| *l. flohri* ..... | 1 | 19.2 | | | |
| *l. abbreviatus* ..... | 3 | 15.3–15.6 | 15.4 | | |
| *chermocki* ..... | 7 | 17.8–20.0 | 18.8 | | |
| *suffusus* ..... | 6 | 12.1–15.5 | 14.4 | | |

*Distribution.*—This species is known only from the type locality and the Chiracahua Mountains in southern Arizona.

Six males and six females of this species from the following localities have been examined.

ARIZONA: Cochise County; Chiracahua Mountains, Pinery Canyon, South Fork (6500′ alt.). MEXICO: Sierra Madre Mountains of Chihuahua.

TABLE 45

Subgenus *Liodicaelus:* VARIATION IN MAXIMUM WIDTH (MM.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *l. laevipennis* ..... | 16 | 7.3–8.7 | 8.2 | 9 | 7.7–9.3 | 8.5 |
| *l. dicaeloides* ..... | 3 | 7.6–7.9 | 7.7 | 11 | 7.6–8.9 | 8.2 |
| *l. flohri* ..... | 2 | 8.8–9.3 | 9.1 | 1 | 8.7 | |
| *l. abbreviatus* ..... | 1 | 7.3 | | 3 | 7.5–7.7 | 7.6 |
| *chermocki* ..... | | | | 7 | 7.8–8.9 | 8.4 |
| *suffusus* ..... | 6 | 5.8–6.5 | 6.2 | 6 | 5.4–6.8 | 6.2 |

TABLE 46

Subgenus *Liodicaelus:* VARIATION IN RATIO W PN/W HEAD.

| Species | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| *l. laevipennis* ..... | 16 | 1.99–2.20 | 2.10 ± 0.01 | 0.05 ± 0.01 | 2.3 |
| *l. dicaeloides* ..... | 3 | 2.00–2.09 | 2.04 | | |
| *l. flohri* ..... | 2 | 2.06 | 2.06 | | |
| *l. abbreviatus* ..... | 1 | 2.10 | | | |
| *suffusus* ..... | 6 | 1.75–2.00 | | | |
| | | Females | | | |
| *l. laevipennis* ..... | 9 | 1.94–2.20 | 2.09 ± 0.03 | 0.08 ± 0.02 | 3.5 |
| *l. dicaeloides* ..... | 11 | 1.92–2.10 | 2.02 ± 0.01 | 0.05 ± 0.01 | 2.5 |
| *l. flohri* ..... | 1 | 2.12 | | | |
| *l. abbreviatus* ..... | 3 | 1.97–2.06 | 2.02 | | |
| *chermocki* ..... | 7 | 1.53–1.71 | 1.62 | | |
| *suffusus* ..... | 6 | 1.73–1.84 | 1.78 | | |

TABLE 47

Subgenus *Liodicaelus:* Variation in Ratio PN: L/W apex.

| Species | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| *l. laevipennis* ..... | 16 | 1.15–1.34 | 1.23 ± 0.01 | 0.05 ± 0.01 | 4.1 |
| *l. dicaeloides* ..... | 3 | 1.25–1.28 | 1.26 | | |
| *l. flohri* ..... | 2 | 1.24–1.30 | 1.27 | | |
| *l. abbreviatus* ..... | 1 | 1.20 | | | |
| *suffusus* ..... | 6 | 1.19–1.23 | 1.20 | | |
| | | Females | | | |
| *l. laevipennis* ..... | 9 | 1.18–1.26 | 1.21 ± 0.01 | 0.03 ± 0.01 | 2.5 |
| *l. dicaeloides* ..... | 11 | 1.15–1.22 | 1.18 ± 0.01 | 0.02 ± 0.008 | 1.7 |
| *l. flohri* ..... | 1 | 1.24 | | | |
| *l. abbreviatus* ..... | 3 | 1.11–1.22 | 1.17 | | |
| *chermocki* ..... | 7 | 0.98–1.05 | 1.00 | | |
| *suffusus* ..... | 6 | 1.10–1.21 | 1.16 | | |

TABLE 48

Subgenus *Liodicaelus:* Variation in Ratio PN: W base/W apex.

| Species | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| *l. laevipennis* ..... | 16 | 1.75–2.00 | 1.88 ± 0.02 | 0.06 ± 0.01 | 3.2 |
| *l. dicaeloides* ..... | 3 | 1.92–1.94 | 1.93 | | |
| *l. flohri* ..... | 2 | 1.92–2.02 | 1.97 | | |
| *l. abbreviatus* ..... | 1 | 1.79 | | | |
| *suffusus* ..... | 6 | 1.64–1.80 | 1.71 | | |
| | | Females | | | |
| *l. laevipennis* ..... | 9 | 1.77–1.95 | 1.86 ± 0.02 | 0.06 ± 0.02 | 3.2 |
| *l. dicaeloides* ..... | 11 | 1.75–1.92 | 1.83 ± 0.01 | 0.05 ± 0.01 | 2.7 |
| *l. flohri* ..... | 1 | 1.83 | | | |
| *l. abbreviatus* ..... | 3 | 1.74–1.91 | 1.84 | | |
| *chermocki* ..... | 7 | 1.35–1.57 | 1.47 | | |
| *suffusus* ..... | 6 | 1.53–1.70 | 1.63 | | |

TABLE 49

Subgenus *Liodicaelus:* Variation in Ratio El: L/W.

| Species | N | Range | Mean | S.D. | C.V. (%) |
|---|---|---|---|---|---|
| | | Males | | | |
| *l. laevipennis* ..... | 16 | 1.42*1.55 | 1.48 ± 0.008 | 0.03 ± 0.005 | 2.3 |
| *l. dicaeloides* | 3 | 1.45–1.48 | 1.46 | | |
| *l. flohri* ..... | 2 | 1.50–1.52 | 1.51 | | |
| *l. abbreviatus* ..... | 1 | 1.33 | | | |
| *suffusus* ..... | 6 | 1.46–1.52 | 1.50 | | |
| | | Females | | | |
| *l. laevipennis* ..... | 9 | 1.40–1.50 | 1.44 ± 0.01 | 0.03 ± 0.007 | 2.08 |
| *l. dicaeloides* ..... | 11 | 1.40–1.54 | 1.44 ± 0.01 | 0.04 ± 0.008 | 2.77 |
| *l. flohri* ..... | 1 | 1.46 | | | |
| *l. abbreviatus* ..... | 3 | 1.30–1.36 | 1.32 | | |
| *chermocki* ..... | 7 | 1.45–1.52 | 1.48 | | |
| *suffusus* ..... | 6 | 1.44–1.55 | 1.48 | | |

## Phylogeny of the Genus *Dicaelus*

The ancestral stock of *Dicaelus* probably differed from the ancestral stock of group 1 of the Licinini (Ancestor 1) in these respects: 1. retinacular tooth of left mandible absent; 2. metepisternum short; 3. wings absent; 4. elytra fused down the mid-line, and interval 7 carinate basally; 5. 6th abdominal sternite with four setae in the males and eight setae in the females; 6. internal sac of the male genitalia with 4 to 6 spines. This hypothetical stock may be called Ancestor 2.

The remainder of this discussion may be followed with reference to diagram 2. The numbers in parentheses refer to the numbers on the diagram. Probably an early differentiation of Ancestor 2 (1 and 9) produced two groups (Ancestors 3 and 4). One of these was the prototype of the subgenus *Liodicaelus* which probably developed smooth elytra, and in which variability decreased in the number of spines on the internal sac (from 4-6 to 5-6). Three allopatric populations may have been developed from this stock, or perhaps from one of its descendants. In one of these (2), the individuals of which were smaller than in the other two, the elytra became suffused with purple, and the pronotum became narrower (*suffusus*); in a second (3), the pronotum became broader, and the lateral margins of the pronotum and elytra became suffused with purple (*laevipennis*); in a third (4), the eyes became flattened and the terebral tooth of the left mandible was lost (*chermocki*). Subsequently, *laevipennis* became differentiated into a number of races: *flohri* (5) retained indications of elytral striae but developed *chermocki*-like mandibles; *laevipennis* (*s. str.*) (6), very similar to *flohri,* lost almost all trace of elytral striae and retained the primitive mandibles; *dicaeloides* in New Mexico (7) lost all indication of elytral striae but developed mandibles like those of *chermocki;* and *abbreviatus* in Mexico lost the elytral carina but retained the primitive mandibles (8).

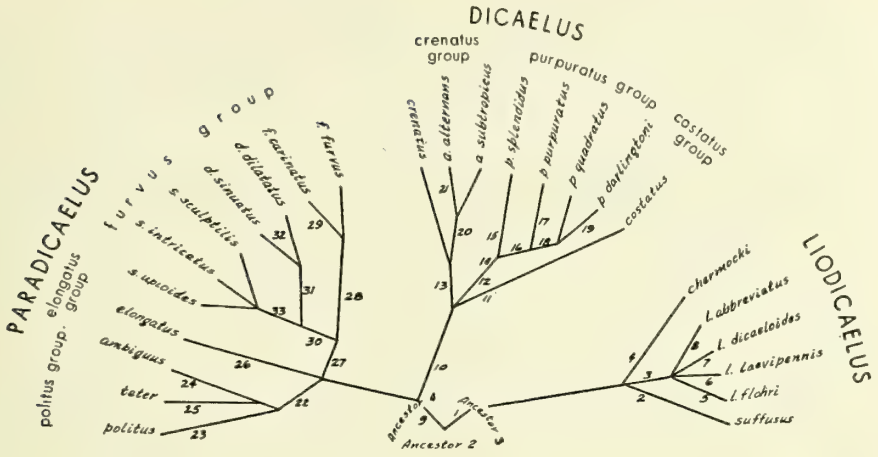


Diagram 2.—A diagrammatic representation of the structural relationships and possible phylogeny of the species of *Dicaelus*.

Reduction in variability in the number of spines on the internal sac (from 4-6 to 4), and development of a median dorsal apical hook on the apex of the median lobe of the male genitalia were possibly the main features which characterized the Ancestor 4 stock. Ancestor 4 may have produced two major lines of descent. In one of these the left mandible lost the terebral tooth, the labial palpi became plurisetose, and the elytral carina lengthened (10). This was the ancestral stock of the subgenus *Dicaelus* (*s. str.*). The living groups of this subgenus are all so different from one another that they probably represent three lineages that differentiated a long time ago, probably in pre-Pleistocene time. Possibly these lines of descent are remnants of a larger and more varied group. The changes which produced the living groups probably did not occur within the course of one species-generation but to simplify the picture I will discuss them as if they did. Probably differentiation of the ancestral stock was along the following lines. In one (11), elytral striae 6 and 7 became joined apically, the apex of the median lobe lost the dorsal hook, became laminate and curved to the left, and the right mandible developed an extra tooth. This stock gave rise to *costatus*. In a second line (12), the dorsal apical plate of the male genitalia became modified (pro-*purpuratus*). In the third lineage (13), the median lobe developed a laminate projection to the right (*crenatus-alternans*).

A later differentiation of the pro-*purpuratus* stock first gave rise to the exerge *purpuratus* which differed from pro-*purpuratus* only in that the elytra lost their melanin (14). Then there evolved a coppery-green color (*splendidus*) followed by the development of the purple color in the more humid environment of eastern North America (15). A divergence of the purple-elytra stock produced *purpuratus-quadratus-darlingtoni* with *purpuratus* (17) developing accessory setae on the 6th abdominal sternite, and *quadratus* (18) developing an extra groove on each side of the pronotum. Finally, differentiation of the *quadratus* stock occurred and a subspecies was developed having the sides of the pronotum more constricted posteriorly, and the color of the dorsal surface more violaceous (19). This is the subspecies *darlingtoni.*

Turning now to the *crenatus* group, it is possible that *crenatus,* itself, represents the ancestral stock with *alternans* having differentiated and developed the unique male genitalia of that species (20). Differentiation of the *alternans* stock produced the living subspecies *alternans* (*s. str.*) (21) and the relatively unmodified *subtropicus.*

The characters of the subgenus *Paradicaelus* are essentially those of Ancestor 4, the three groups of this subgenus are quite distinct from one another, and each line seems to be specialized in some particular way. The ancestral stock of the *politus* group retained the primitive male genitalia, differentiating from the ancestral stock of *Paradicaelus* in mandibular structure (22). A relatively early differentiation of the *politus* stock produced the species *politus* and the ancestral stock of *teter-ambiguus,* with *politus* developing a specialized apex of the median lobe and a relatively slender pronotum, and losing the carinate portion of interval 7, and having the number of setae on the 6th abdominal sternite reduced (23). Later the *ambiguus-teter* line differentiated into two species (24, 25), each species developing its characteristic pronotum and *ambiguus* developing a protuberance on the dorsal surface of the left mandible.

The stock which gave rise to *elongatus* (26) probably developed a slightly specialized plate at the apex of the median lobe, an extra pair of setae on the pronotum, and a more elongate elytral carina.

The archetype of the *furvus* group (27) probably developed mandibles of the *furvus* type and the specialized dorsal apical plate of the internal sac. From this stock two lines of descent developed. In one of

these (28), a protuberance developed on the dorsal surface of the left mandible and the elytral carina became elongate. This species, *furvus,* differentiated into two races with *f. furvus* retaining the primitive characters and intervals 3 and 5 becoming wider in *f. carinatus* (29).

The second stock arising from the *furvus* group archetype became relatively broader (30). From this line evolved *dilatatus* in which one spine on the internal sac dropped out (31). The less derived race of this species is *d. dilatatus* and from this stock *d. sinuatus* probably arose (32). The second major component of the *dilatatus-sculptilis* lineage, *sculptilis,* retained the primitive number of spines on the median lobe. However, the elytral striae became punctate, ocellate punctures developed in the elytral intervals, and the striae became broken (33). Finally this species differentiated to produce three geographical races, the most derivative of which seems to be *upioides.*

If this genealogy is essentially correct, then some characters have been developed a number of times independently. The following features have been developed twice: increase in width relative to length; protuberance on the dorsal surface of the left mandible; loss of the elytral carina; reduction of the dorsal apical plate, with the resulting shift in position of the opening of the ejaculatory duct; relative widening of elytral intervals 3 and 5. The elytral carina has become elongate four times. The terebral tooth of the left mandible appears to have been lost six times.

## Zoogeography of the Genus *Dicaelus*

A general account of the history of this group cannot be given because of the relatively extensive sympatry exhibited by the Recent species. Thus, discussion must be in large measure restricted to the closely related forms which are partially or wholly allopatric. The fact that the species groups are so well defined morphologically suggests that much extinction has taken place, and therefore a large amount of information required for a study of this nature has been lost.

The absence of *Dicaelus* from the Neotropical Region, the Old World, and the higher latitudes of North America suggests that the genus is an old resident of the Nearctic. Its structural characteristics suggest that it is related to *Diplocheila,* and so the ancestral stock of *Dicaelus* may have come via the Bering land bridge from the Old World in early Tertiary time when temperate conditions extended far

to the north, and the Arcto-Tertiary flora lay within eight degrees of the North Pole (Chaney, 1947). This ancestral stock may have become widespread, ultimately producing the three extant subgenera. One of these, *Liodicaelus,* may have arisen in the area of the Madro-Tertiary plant association in Mexico. A second, *Dicaelus* (*s. str.*), may have differentiated under subtropical conditions in eastern North and Middle America, and the third, *Paradicaelus,* arose in the environs of the Arcto-Tertiary floral association. Today, *Liodicaelus* is associated with the Madro-Tertiary flora, *Paradicaelus* with the Arcto-Tertiary flora, and *Dicaelus* (*s. str.*) largely with the latter flora. However, most of the species of *Dicaelus* (*s. str.*) range or occur far enough south that it seems reasonable to postulate that the center of origin of the subgenus was subtropical.

With the cooling of the climates in late Tertiary time, the Arcto-Tertiary forest was driven south and survived largely in eastern United States and northeastern Mexico. *Paradicaelus* would also have been driven southward and seems to have survived largely to the east of the 100th Meridian. Possibly during this period, most of the species of *Dicaelus* (*s. str.*) were exterminated, leaving only the three groups which are extant today. For the sake of the argument, let it be assumed that at the beginning of the Pleistocene the distribution of the subgenera of *Dicaelus* was essentially as it is today. On this hypothesis I will discuss the evolution of the present day pattern of distribution within each subgenus.

Because most of the forms of the subgenus *Liodicaelus* are known from a very few localities, and their ranges are therefore poorly understood, their distribution will not be considered further.

By late Pliocene-early Pleistocene time, the ancestral stocks of the three groups of *Dicaelus* (*s. str.*) were probably differentiated. The area east of the Rockies was probably occupied, as it is today, by the wide-ranging *purpuratus* stock. Probably the ancestral stock of the *crenatus* group, as well as the progenitor of *costatus,* lived in the vicinity of the Gulf Coast and ranged farther westward in Mexico. The cooling climate of the glacial epoch forced the Nearctic biota southward, and the warm-adapted elements may have been forced into a Mexican refugium to the west and a Floridian-southeastern refugium in the east. Geological evidence indicates that although most of the

Floridian peninsula was submerged during interglacial stages, during the glacials there was much land above sea level (Hubbell, 1954: 46-51). Palaeobotanical evidence indicates that the Rocky Mountain coniferous forest spread southward almost to the Gulf Coast during at least one glacial stage, and cool-adapted elements in the Appalachian flora moved down on to the Coastal plain (Beecher, 1950: 77). If this did happen, then the originally continuous warm-adapted species could have been divided into two units: one to the east, and one to the west. Possibly, while thus isolated, the *purpuratus* stock differentiated, producing *splendidus* in the west and *purpuratus-quadratus* in the east. Similarly, the *crenatus-alternans* stock may have differentiated to produce *crenatus* in the west and *alternans* in the east. *Costatus* possibly did not survive in the eastern refugium, was not there at all, or, if there, did not differentiate from the western counterpart. During an interglacial stage, part of the *purpuratus-quadratus* stock may have become isolated on one of the Floridian islands and differentiated from the mainland stock, giving rise to *quadratus*. Subsequently this form spread throughout peninsular Florida, ultimately invaded the mainland, differentiating to produce *quadratus* and *darlingtoni* which may be cline-end subspecies. The same thing may have happened to the species *alternans*, producing the subspecies *alternans* and *subtropicus*. With the return of the warmer climatic conditions, the various species spread, attaining their present day range.

A similar course of events would explain the distribution pattern of some of the species of *Paradicaelus*. In late Pliocene-early Pleistocene time these species may have existed: ancestral *elongatus;* ancestral *politus;* common ancestor of *ambiguus* and *teter;* ancestral *furvus;* common ancestor of *dilatatus* and *sculptilis*. These species probably did not range far east of the 100th Meridian. With the cooling of the climate they were forced southward, just as in the case of the species of *Dicaelus* (*s. str.*). Probably the ancestral stock *dilatatus-sculptilis* and *teter-ambiguus* occupied both refugia, whereas *politus*, *elongatus*, and *furvus* occupied only the eastern refugium. *Dilatatus* and *teter* probably arose in the eastern refugium, and their counterparts, *sculptilis* and *ambiguus*, in the western one. As the climate warmed, in an interglacial or post-glacial stage, the biota moved northward, *politus* and *teter* along the Appalachians, and *furvus*, *dilatatus* and *elongatus* along

both flanks of this mountain range. From the western refugium, *ambiguus* and *sculptilis* migrated northward and then eastward.

The subspecies of *furvus, dilatatus,* and *sculptilis* may have developed in post-glacial time. The variation in characters which distinguishes them seems to be continuous, and this suggests that there has been continuous gene flow between the terminal populations *via* the structurally and geographically intermediate populations. I am not prepared to discuss the reasons why the terminal populations or series of populations of these three species are more strongly differentiated than those of the remaining species. However, I suspect the answer lies in such factors as rate of dispersal, ecological amplitude, and perhaps the range of the species during the last glacial stage. Rate of dispersal would determine how long it would take populations moving northward on both sides of the Appalachians to meet in the north, and thus the time span of isolation of the terminal populations; ecological amplitude would determine whether or not the mountains would serve as a barrier; and range of the species during the last glacial epoch would to some extent determine the amount of differentiation that could develop between terminal populations before the movement northward began.

This rough sketch of the history of the genus is doubtless oversimplified. However, it could be much improved if the ecology of the species were better understood. With regard to the background against which this action was supposed to have taken place, we do not know if the more southerly elements of the fauna of eastern United States were divided, but this assumption makes it possible to explain a number of cases of species distribution patterns similar to those discussed above which makes the hypothesis more tenable. For example: in the genus *Helluomorphoides,* the species-pairs *texanus-clairvillei* and *ferrugineus-praeustus* (Ball, 1956); the orioles, *Icterus galbula* and *bullocki* (Beecher, 1950: 77); the mouse species-pairs, *Peromyscus maniculatus-polionotus* and *leucopus-gossypinus* (Blair, 1943: 183-184); the well-marked subspecies of the narrow-mouthed toad genus, *Microhyla, c. carolinensis* and *c. olivacea* (Hecht and Hecht, 1946). (See also the discussion of zoogeography of *Diplocheila* and *Badister.*) The existence of at least islands since the Pliocene in the area of what is now central Florida can hardly be doubted because of the large num-

ber of endemics which occur in Florida and which give evidence of long isolation (Hubbell, 1954: 48). During glacial stages, when the sea level was low, the island or islands could have been joined to the mainland, and then isolated during the interglacials when the sea level rose. Thus during the glacial stages they would function as parts of the southeastern refugium, and during the interglacials as areas in which segments of predominantly mainland species became isolated and thus ultimately differentiated.

## Genus **BADISTER** Clairville

The most obvious diagnostic features of *Badister* (s. lat.) are presented in the key. Other useful characters are given in the following description which is taken in large part from Jeannel (1942: 1000).

*Description.*—Length not exceeding ten millimeters, body glabrous, excepting certain constant setae which are mentioned below.

Head with two supraorbital setigerous punctures over each eye, frontal impressions usually shallow, basin-like, eyes prominent. Clypeus strongly and slightly asymetrically emarginate, not divided into two portions by the emargination, deflected ventrally, forming an angle of somewhat less than 90 degrees with the front, bearing a single long seta on each side, each of which originates in a broad approximately triangular pit. Labrum about 2/3 as wide as clypeus, deeply bilobed, cleft anteriorly almost to the base, bearing six setae, one at base, one at apex, and one in between on inner margin, on each lobe. Mandibles very short and obtuse, terebra strongly reduced, apparently edentate. Segments of maxillary palpi long and slender, terminal segment fusiform, slightly broader than preceding segments, narrowly truncate, apically. Penultimate segment of labial palpus bisetose. Antennae with pubescence beginning on segment 3.

Pronotum wider than head, more or less cordate, a pair of setigerous punctures on each side, one at each posterior lateral angle, one on each side just inside of lateral margin about half way between base and apex; narrowly margined laterally, hind angles obtuse, slightly to strongly rounded; microsculpture of proepisternum longitudinal, fine, transverse on the remaining lateral and ventral thoracic sclerites; apex of prosternum feebly margined, without setae; metepisternum elongate, the outer margin about 1.5 times greater in length than the anterior margin, posterior margin about .75 times anterior margin. Legs slender; tibial spurs very finely serrulate; posterior tarsi very slender, dorsal face dull and medially feebly sulcate; anterior tarsi of male with segments 1-3 dilated and with "spongy pubescence" on ventral surface.

Elytra oblong, wider than thorax at widest point, apical margin entire or very slightly sinuous, striae fine, scutellar stria present and long, between stria 1 and scultellum; intervals flat (except in *B. notatus*) with two discal punctures on interval 3, close to stria 2.

Abdomen with very fine, transverse microsculpture, the lines very close together, the surface strongly iridescent. 6th abdominal sternite with two setigerous punctures on posterior margin in male, four in female, this margin more rounded in the male, more truncate in the female.

Male copulatory organs—median lobe moderately arched (in typical subgenus, straighter in subgenus *Baudia*), (figs. 134-155); basal bulb somewhat reflexed, margins not emarginate, dorsally largely membranous.

*Distribution.*—Representatives of this genus occur in the Antillean subregion of the Neotropical Region, the Holarctic Region, Oriental Region eastward to Java, and Ethiopian Region, in the Cape subregion, and on the island of Madagascar.

*Subgeneric Classification.*—This genus was divided into two subgenera by Ragusa (1884) and the two groups have been treated as such until recently. Jeannel (1942: 1004) elevated *Baudia* to the status of genus, and divided *Badister* (*s. str.*) into two groups: subgenus *Badister* and *Trimorphus* Stephens, the latter including only *B. sodalis*. His principal reason for elevating *Baudia* to the status of genus involved differences in the structure of the dorsal lobe of the male genitalia between the two groups. In his key on pages 999-1000 (1942) Jeannel stated that the apical orifice of the median lobe is closed ("ferme") by two symmetric strips in *Badister,* as in *Licinus,* whereas these two plates are not present in *Baudia.* I have studied the median lobes of representatives of the type species of the three groups involved and found that the dorsal area in *Licinus cassideus* bears three short sclerotized strips, the median one arising from the right strip; in *Badister bipustulatus* there are three strips, the median one of which is not connected to either lateral strip, but bends toward the left; the left lateral strip originates well above the level of origin of the right strip; in *Baudia peltata* there are only two strips, both of which originate from the apex of the basal bulb and are lateral in position; and no median strip is present. I believe that the dorso-lateral strips are homologues of one another and that the median ones probably are not. In any case, with respect to the characters mentioned above, *Baudia peltata* differs from *Badister bipustulatus* only in lacking the median strip, so I fail to see what Jeannel had in mind. In the *pulchellus* complex of *Badister* (see below) the median lobe also lacks this strip, and in *Badister* (*Baudia*) *reflexus* Le Conte the median strip is present but very feebly indicated. This character, in the complex, hardly seems to

be of generic value. Because of the overall similarity of the groups *Badister* and *Baudia* I feel that they should be considered as subgenera of a single genus, but that *Badister sodalis* should be in a separate subgenus as was indicated by Jeannel. By utilizing a single character, the notching of the mandibles, it would be necessary to place the species of *Trimorphus* in the subgenus *Badister.* This character, then, would be the only reliable one to separate *Badister* (*s. str.*) from *Baudia.* If we use pronotal microsculpture and absence of setae on the ventro-lateral margins of the claw-bearing tarsal segment as the basis for classifying the species, then the species of *Trimorphus* would go with *Baudia.* As it does not seem possible to assess very accurately the relative values of these characters for classificatory purposes, it seems advisable to use a combination of them. By so doing, it seems desirable to place in a separate subgenus the species having the right mandible notched, the microsculpture forming transverse meshes on the pronotum, and lacking setae on the ventro-lateral margins of the claw bearing segment, and in a linear sequence, to place this subgenus between the other two.

Subgenus **Badister** Clairville

*Badister* Anonymous [Clairville], 1806: 90.

GENOTYPE: *Carabus bipustulatus* Fab. (Monobasic).

*Amblychus* Gyllenhal, 1810: 74; (included species—*Licinus bipustulatus* Latr., *Carabus bipustulatus* Fab., *Carabus crux-minor* Oliv., and *Carabus peltatus* Panzer).

GENOTYPE: *Carabus bipustulatus* Fab; (designated by Jeannel, 1942: 1000).

In addition to the features presented in the keys, all of the North American species of the typical subgenus have a row of setae on each latero-ventral margin of the terminal tarsal segments. Another useful character in distinguishing the subgenera is the relative length of the hind tarsi. In *Badister* and *Trimorphus* the hind tarsi are more than 3/4 the length of the hind tibiae; in *Baudia,* the hind tarsi are perceptibly relatively shorter.

*Distribution.*—The distribution of *Badister s. str.* is more restricted than that of the genus as a whole, as this subgenus is not represented in the Ethiopian Region nor in the Antillean subregion of the Neotropical. The southernmost record for *Badister s. str.* in the New World is Oaxaca, Mexico, on or near the edge of the Neotropical Region.

### *Key to the Nearctic Species of Subgenus Badister*

1. Anterior margin of proepisternum and lateral margins of prosternum distinctly rugose; penultimate segment of maxillary palpus distinctly shorter than terminal segment; head and pronotum black, shining surface of pronotum not reticulate (i.e. lines of microsculpture lacking), head faintly reticulate (lines of microsculpture very fine, hardly discernible at magnification of 18 dia.); elytra rufo-piceous, striae deep, finely punctate, intervals narrow, convex ..... *B. notatus* Hald.

   Anterior margin of proepisternum and prosternum not rugose, but rugulose in some specimens; penultimate segment of maxillary palpus distinctly shorter than or subequal to terminal segment; surface of head and pronotum distinctly micro-reticulate or strongly iridescent; elytral striae shallow, the intervals relatively broad and flat ..... 2

2. Elytra not iridescent, lines forming microsculpture relatively far apart, forming obvious meshes (as seen under magnification of 54 dia.) *B. obtusus* LeC.

   Elytra strongly iridescent, lines forming microsculpture relatively close together, not forming obvious meshes (as seen under magnification of 54 dia.) ..... 3

3. Elytra either concolorous or somewhat paler at base, but not sharply bicolored ..... 4

   Elytra sharply bicolored ..... 8

4. Elytra black ..... 5

   Elytra piceous to rufescent ..... 7

5. Legs rufous, or darker ..... *B. ferrugineus anthracinus* LeC.

   Legs testaceous ..... 6

6. Lateral margins of pronotum rounding evenly into lateral portion of basal margin, the posterior angles thus broadly rounded *B. flavipes flavipes* Lec.

   Lateral margins of pronotum sinuate posteriorly, forming a shallow notch in front of posterior marginal setigerous punctures, posterior angles obtuse, narrowly rounded ..... *B. flavipes mexicanus* Van Dyke

7. Pronotum with base relatively narrow (W base/W apex 0.93-1.07, W base /L pn 0.96-1.10), antennae testaceous to rufo-testaceous throughout *B. flavipes laticeps* Blatchl.

   Pronotum with base relatively broad (W base/W apex 1.05-1.16, W base /L pn 1.18-1.33), segments 4-7 of antennal flagellum rufo-piceous or darker, distinctly darker than rest of antenna *B. ferrugineus ferrugineus* Dej.

8. Pronotum orange-testaceous, not black ..... 9

   Pronotum black, not orange-testaceous ..... 10

9. Metepisternum orange-testaceous, or at least paler than metasternum, penultimate segment of maxillary palpus distinctly shorter than terminal segment; scape of antenna uniformly testaceous throughout *B. pulchellus* LeC.

Metepisternum black, or at least as dark as metasternum, penultimate segment of maxillary palpus only very slightly shorter than or equal in length to the terminal segment ..... *B. neopulchellus* Lindroth

10. Sides of pronotum distinctly sinuate before hind angles, the angles therefore prominent ..... *B. vandykei* n. sp.
Sides of pronotum not sinuate before hind angles, angles obtusely rounded ..... 11

11. Pronotum relatively long and slender (W pn wp/L pn 1.15-1.35), elytral interval 1 in basal 1/3 not darker than intervals 2-8 ... *B. elegans* LeC.
Pronotum broadly cordate, relatively short and broad (W pn wp/L pn 1.40-1.55), elytral interval 1 black, or at least distinctly darker than intervals 2-8, at least in basal 1/3 ..... *B. maculatus* LeC.

## Classification of the North American Species of the Subgenus *Badister*

Although I do not believe the male genitalia are *a priori* more fundamental than all other characters, in the North American species of this subgenus the variation of the genitalia is so complex that it probably gives a good picture of the relationships of the species. The classification of this subgenus and of the subgenus *Baudia* rests on this thesis.

The female retractile plates are also of value in *Badister,* especially when considered with the male genitalia.

The most useful features are, firstly, the presence or absence of the second (ventral) apical plate of the internal sac; secondly, the presence or absence and the arrangement of preapical spines on the internal sac; and, thirdly, the number of dorsal sclerotized strips on the median lobe —two or three. The form of the apex of the median lobe differs in every North American species of *Badister,* and the number and arrangement of preapical plates on the internal sac differ in most species of the *Badister bipustulatus* complex seen by me, so these characters are of little value in grouping the species. Neither color nor body proportions seem to be of any value. A summary of the arrangement of the species studied follows.

I. *bipustulatus* complex.

Median lobe of male genitalia with three sclerotized strips, left originating above plane of origin of right, median strip short, free; internal sac with two apical plates, dorsal plate tapering to form a broad triangle or slender spicule; preapical spines absent, preapical plates present or absent, one to three in number. Digitus of female retractile stylus relatively broad, basal median angle broadly rounded, hairs on outer margin short and broad (fig. 159). The lobes of the 8th sternite are narrower than in the following complex (fig. 156). Microsculpture of pronotum like that of head, or at least more like that of head than like elytra.

A. *bipustulatus* group.

Median lobe narrowly hooked apically, apical portion not inclined ventrally nor inflated to form a large protuberance; internal sac lacking preapical plates.

Included species (those names preceded by a question mark are of species not studied by me; in placing them here I am going on the basis of Makolski's very able study (1952):

*Badister bipustulatus* Fabricius
? *Badister lacertosus* Sturm
? *Badister kineli* Makolski
? *Badister fenestratus* Semenov

B. *neopulchellus* group.

Median lobe apically inclined ventrally, with or without an inflated apical protuberance; internal sac with one to three preapical plates.

Included Species:

*Badister unipustulatus* Bonelli
*Badister neopulchellus* Lindroth
*Badister obtusus* Le Conte
*Badister ferrugineus* Dejean
*Badister pictus* Bates

II. *pulchellus* complex.

Median lobe of male genitalia with two sclerotized strips; internal sac with a single apical plate; two preapical spines present, preapical plates absent. Digitus of stylus of female retractile plates elongate and slender, setae on posterior margin of stylus long and slender. Terminal tarsal segments with a row of setae on each ventro-lateral margin. Microsculpture of pronotum either like that of head or elytra.

A. *pulchellus* group.

Male genitalia with two dorsal sclerotized strips, both originating at same level, from apex of basal bulb; median strip absent; internal sac with two small spines located dorsally. Microsculpture of pronotum like that of head.

Included species:

*Badister pulchellus* Le Conte

B. *elegans* group.

Male genitalia with two dorsal sclerotized strips, as in the preceding group; internal sac with two well developed spines, one dorsal, one lateral in position. Microsculpture of pronotum like that of head, or completely lacking.

Included species:

*Badister elegans* Le Conte
*Badister maculatus* Le Conte
*Badister vandykei,* n. sp.
*Badister f. flavipes* Le Conte
*Badister f. laticeps* Blatchley
*Badister f. mexicanus* Van Dyke
*Badister notatus* Haldeman

## The *bipustulatus* complex

### *neopulchellus* group

The characteristics of this group are presented in the preceding section.

The group ranges from the Pacific Coast (California to British Columbia) to the Atlantic, in the Canadian Life Zone forests, and southward in the plains to Texas, and on the Atlantic Coast to New Jersey.

**Badister** (*s. str.*) **neopulchellus** Lindroth

*Badister neopulchellus* Lindroth, 1954: 153, fig. 13d; [I have not seen the type, but have seen specimens determined by Lindroth as *B. neopulchellus*]. Type locality: West Roxbury, Suffolk Co., Massachusetts; (determined from original description).

This species, one that has long been confused with *B. pulchellus* Le Conte, may be distinguished from the latter by the characters presented in the keys. Further, the sides of the elytra are more nearly parallel than in *B. pulchellus.*

*Description of color and microsculpture.*—Male. Wollaston, Mass.

Color. Antennae with scape testaceous, apically infuscated, segments 2-6 piceous, segments 7-11 rufo-testaceous; elytra orange-testaceous, with an irregular black spot occupying about apical 1/6, not contacting sutural interval, and a median black spot between striae 1-8, well separated from apical spot; the following black—head, lateral and ventral sclerites of pterothorax, excluding mesepisterna which are suffused with rufous especially basally, and abdomen,

excluding rufous apex of 6th segment; the following rufo-piceous—mandibles, labrum, and hind coxae; terminal palpal segments and legs excluding hind femora rufous, subterminal segments of palpi testaceous; the following orange-testaceous—prothorax, elytral epipleurae, scutellum, elytra, as described above, and femora.

Microsculpture. Isodiametric on head and pronotum, these sclerites shining, not iridescent; elytra with line of microsculpture very close together and transverse, not forming obvious meshes; iridescence pronounced.

*Variation.*—I am not presenting an analysis of variation in body proportions because this species can be separated from all other members of the genus without resorting to such characters.

Size variation is as follows: males, length 5.15-5.80 mm. (5.53 mm.), width 2.05-2.45 mm. (2.28 mm.); females, length 5.32-6.12 mm. (5.67 mm.), width 2.25-2.55 mm. (2.42 mm.).

The amount of black pigment present seems to vary geographically with a maximum amount, on the average, exhibited by specimens collected in west coast localities, decreasing eastward, reaching a minimum in the Great Plains area and increasing again in the northeast.

Variation in color of other body parts is slight. The mesepimeron varies from black to rufo-piceous, the mesosternum from black to rufo-testaceous; the metepisternum in all specimens examined is as dark as the metasternum.

The pronotum exhibits considerable variation in shape, the sides, on the average, rather narrowly rounded anteriorly and straightening posteriorly, but some specimens have the sides rather broadly rounded, as broad as is the specimens of *B. pulchellus.*

The genitalia (figs. 134a-b) of sixty-five males have been examined and they exhibit virtually no variation in shape of the median lobe or armature of the internal sac.

The retractile plates of three females do not exhibit any variation. (See Figs. 156, 157, and 158.)

*Distribution.*—The range of this species is transcontinental in the north, extending from southern British Columbia eastward to Massachusetts, and from McMurray, Alberta in the north, southward to " Texas," in the plains. On the east coast I have not seen specimens of *B. neopulchellus* from south of New Jersey, and on the west coast south of the state of Washington. Under the name *pulchellus,* this species has been reported from Raleigh, North Carolina by Brimley (1938: 122), from Hiawassee and Lakemont, Georgia by Fattig

(1949: 32), and from several localities in New York State by Notman (in Leonard, 1926: 230). Notnam (*ibid.*) has also recorded a specimen, probably of this species, from St. Lawrence County, New York, under the name *Badister bipustulatus.*

**Badister** (*s. str.*) **ferrugineus** Dejean

The morphological diagnostic features of this species are summarized in the keys. The typical subspecies could be confused with *Badister obtusus,* but the iridescent elytra and apparent lack of meshes formed by the microsculpture, characteristic of *B. f. ferrugineus,* distinguishes it from *obtusus.* The atypical subspecies, *B. f. anthracinus,* is colored like *B. flavipes flavipes* and *B. flavipes mexicanus,* excluding the color of the legs (black in the former, testaceous in the latter species), but the very narrowly rounded posterior angles of the pronotum of *B. ferrugineus anthracinus* contrast markedly with the broadly rounded posterior pronotal angles of *B. flavipes flavipes.* In addition, the geographical distribution of these forms is very different, *anthracinus* occurring on the west coast eastward to Nevada, and the two subspecies of *flavipes* in southeastern United States and southern Mexico.

The species *Badister ferrugineus* Dejean includes the subspecies *B. f. ferrugineus,* known only from California, and *B. f. anthracinus,* described from a specimen collected in Oregon, and ranging from Vancouver Island, B. C., southward to California and eastward to Nevada.

The following characters seem to be of diagnostic, or partially diagnostic, value in distinguishing between the subspecies: color, relative proportions of the head, and shape of the apical protuberance of the median lobe of the male genitalia.

Typical specimens of *anthracinus* exhibit these characters: dorsal surface of pronotum and elytra black, ventral surface entirely black, legs rufous to rufo-piceous, palpi and antennae variable but usually rufo-piceous; head usually relatively small, more so in the males than in the females (see tables following discussion of variation); the apical protuberance of the median lobe is shorter, and the dorsal "tooth" is less prominent (figs. 135-137; cf. figs. 138-144).

Typical specimens of *ferrugineus* are predominantly paler in color, usually with only the head black; the palpi, antennae and legs are also paler on the average than in *B. anthracinus;* the head is relatively

larger, but *not* as wide as the prothorax, as was said to be the case by Le Conte (1880: 165), and the apical protuberance of the median lobe is longer, narrower, and has a more prominent dorsal " tooth " than in *B. anthracinus*. (See figs. 140-144; cf. figs. 135-139.)

In addition to the two combinations of characters listed above, another combination has been observed: males that are *anthracinus* in color, with *ferrugineus*-like genitalia, or intermediate genitalia. In addition, certain specimens are referable to *B. ferrugineus* on the basis of general proportions, but exhibit an appreciable amount of dark coloration. The difference in head size is average, not absolute, as is indicated in the following tables.

In the absence of a single absolute diagnostic character or combination of characters, I conclude that *B. ferrugineus* and *B. anthracinus* are conspecific. However, since typical representatives of these two named forms are allopatric, they are treated here as subspecies.

**Badister ferrugineus ferrugineus** Dejean

*Badister ferrugineus* Dejean, 1831: 690; [type in Oberthür Coll., (fide Lindroth)]. Type locality; California, (Eschscholtz); (determined from original description).

The diagnostic features of this subspecies are presented in the preceding section.

*Microsculpture.*—Microsculpture approximately isodiametric on head and pronotum (slightly transverse on pronotum); strongly transverse on elytra, and lines very close together, not forming an obvious mesh work; elytra strongly iridescent.

*Variation.*—Data on variation in length and width are presented in tables 50-51. Color variation is extensive, although only slight in degree, ranging from testaceous to dark piceous. The head is black in all specimens, except one female from Brentwood, Cal. where it is a very dark brown. The palpal segments are generally paler basally than apically, and the apical portions of the terminal segments are darkest. Within this pattern, color of the palpi varies from testaceous to rufo-piceous. Antennal segments exhibit similar variation, the scape being usually paler than remaining segments. The pronotum varies in color from rufo-testaceous to dark rufo-piceous, the disc usually darker than the marginal areas. The pronotal epipleurae are mostly testaceous. Lateral sclerites of the prothorax vary from rufo-

testaceous to dark rufo-piceous, averaging slightly paler than the pronotum on individual specimens; the prosternum varies similarly. The lateral and ventral sclerites of the pterothorax vary from rufous to piceous, are for a given specimen darker than the lateral and ventral sclerites of the prothorax. The legs vary from testaceous to rufo-piceous (two specimens). The elytra exhibit the same range of variation in color as the pronotum and are usually more or less the same color as the pronotum for a given specimen.

Of the specimens examined from Brentwood, California, twelve are definitely predominantly testaceous to rufous and the other two are definitely darker, almost as dark as typical *anthracinus*. A single female from San Luis Obispo, Cal. has its dorsal surface almost as dark as typical *anthracinus* but the ventral surface is somewhat paler. The remaining specimens studied are all definitely lighter in color than are specimens of typical *anthracinus*.

*Variation in measurements and ratios.*—The diagnostic mensural characters of both subspecies are discussed in this section. There are slight mean differences in length and width between these subspecies but they are too slight to be of any taxonomic value (see tables 50 and 51). Head size, i.e. length and width, is on the average greater in *ferrugineus* than in *anthracinus*. This difference is more strongly marked in the males than in the females. To indicate this numerically, the ratio W head/W left elytron was determined for each specimen of the two nominate forms (table 52). A similar pattern is indicated in table 53 for head length. Here elytral width is the numerator, head length the denominator.

The ratios L pn/L head and W pn wp/W head were included only for purposes of comparing this species with *B. obtusus* (see tables 54 and 55), and the ratios W pn base/W pn apex and W pn base/L pn were used to compare *obtusus* and *ferrugineus* with *B. flavipes laticeps*, a species to which the former are not closely related, but one with which they may be confused.

*ferrugineus*, I suspect, already has been confused with *laticeps*, as the former species has been recorded from New York (Notman, in Leonard, 1926: 230). I have not seen the specimen on which this record was based, nor have I seen any specimens of *f. ferrugineus* from localities east of the Sierra Nevada and therefore doubt very strongly

the validity of this record. In all probability the specimen was a misidentified representative of *B. flavipes laticeps* which superficially resembles *f. ferrugineus*. I have seen representatives of the former race from New York State.

*Distribution.*—I have seen nine males and ten females which were collected in the following localities.

CALIFORNIA: "Cala." Contra Costa County; Brentwood. Inyo County; Bishop. S. L. Obispo County; S. L. Obispo. "San Francisco County." Santa Clara County; L. Gatos, Palo Alto.

**Badister ferrugineus anthracinus** Le Conte, new combination

*Badister anthracinus* Le Conte, 1889: 83 [type specimen a female, in Le Conte Coll., MCZ No. 5724]. Type locality: "Oregon"; (determined from original description, and label on type specimen).

The diagnostic features of this subspecies are presented above in conjunction with the diagnosis of the typical subspecies.

*Variation.*—Size variation is presented in tables 50 and 51. Color variation is insignificant in specimens from Oregon and northward. The body is generally black, with legs, palpi, antennae and epipleurae rufo-piceous, but terminal segments of antennae vary to rufo-testaceous. Two specimens from "Nevada" are uniformly rufo-piceous, but they may be teneral. The California specimens exhibit appreciably more variation in color, and are discussed below.

Data on variation in diagnostic or partially diagnostic ratios are presented in tables 52-57—W head/W l. elytron, W l. elytron/L head, L pn/L head, W pn/W head, W pn base/W pn apex, W pn base/L pn. Pronotum as in figure 119b.

Male genitalia as in the figs. 140-144.

*Distribution.*—Seven males and nine females representing this subspecies have been studied. They were collected in the following localities.

BRITISH COLUMBIA: Van.; Vanc. I.; Victoria. NEVADA: "Nev." OREGON: "Or." Benton County; Corvallis. Klamath County; Klamath. WASHINGTON: Pierce County; Tacoma.

**Badister f. ferrugineus × anthracinus**

Specimens included in this category are Californian, predominantly black in color; the males have narrow heads and generally the propor-

tions of *anthracinus,* but the genitalia are more like those of the typical specimens of *anthracinus,* tending toward *ferrugineus.* They are therefore regarded as transitional specimens between the typical members of the two subspecies. Because the males are structurally different from typical *anthracinus,* it seemed advisable to treat them as a separate unit for purposes of presenting the numerical data. The California *anthracinus* females are treated similarly, even though they are not much closer in proportions to *B. ferrugineus* then they are to the females from more northern localities.

*Distribution.*—Four males and nine females, included in this category, were collected in the following localities.

CALIFORNIA: Alameda County; Alameda. Fresno County; King's River. Lassen County; Poison Lake. "Los Angeles County." Madera County; Chiquito Creek. "San Francisco County." County not determined; Ingleside.

**Badister** (*s. str.*) **obtusus** Le Conte

*Badister obtusus* Le Conte, 1878: 594; [type specimen a female in Le Conte Coll., MCZ No. 5723]. Type locality: Marquette, Michigan, 28.6; (determined from label on type specimen). Lindroth, 1954: 153.

The lack of elytral iridescence and the evident mesh-work formed by the lines of microsculpture are the most obvious characters for separating this species from its North American congeners.

*Description of microsculpture.*—Microsculpture: on dorsal surface of head and pronotum, approximately isodiametric; transverse on elytra, but transverse lines far enough apart so that connecting lines between them can be seen, thus forming a mesh work. Dorsal surface of body without a trace of iridescence.

*Variation.*—Data on variation in the following measurements and ratios are presented in tables 50-57—length, width, W head/W l. elytron, W l. elytron/L head, L PN/L head, W PN/W head.

The pronotum is as in figure 120.

I have seen three males of this species, and their genitalia were identical (figs. 145a and b).

*Distribution.*—This species, probably a resident of the Canadian Zone forest, has been collected in eastern Montana, southern Manitoba, northern Michigan, and Quebec.

I have seen five males and sixteen females collected in the following localities.

ALBERTA: Medicine Hat. COLORADO: "Col." MANITOBA: Aweme, Winnipeg.

MICHIGAN: Mackinac County; St. Ignace. Marquette County; Marquette. County not determined; Isle Royale. MONTANA: Lewis and Clarke County; Helena. QUEBEC: Duparquet. No LOCALITY: one male.

TABLE 50

*Neopulchellus* group (in part): TOTAL LENGTH (MM.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *obtusus* ..... | 3 | 5.55–6.08 | 5.88 | 17 | 5.32–6.25 | 5.89 |
| *anthracinus* T* ... | 6 | 5.45–5.78 | 5.76 | 11 | 5.40–6.45 | 5.89 |
| *anthracinus* C† ... | 4 | 5.50–6.25 | 5.90 | 8 | 5.52–6.25 | 6.03 |
| *ferrugineus* ..... | 9 | 5.48–6.33 | 5.98 | 10 | 5.70–6.50 | 5.99 |

* T, "typical" specimens.
† C, California specimens.

TABLE 51

*Neopulchellus* group (in part): MAXIMUM WIDTH (MM.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *obtusus* ..... | 3 | 2.25–2.70 | 2.53 | 17 | 2.30–2.80 | 2.56 |
| *anthracinus* T .... | 6 | 2.40–2.55 | 2.46 | 11 | 2.45–2.88 | 2.62 |
| *anthracinus* C .... | 4 | 2.35–2.80 | 2.51 | 8 | 2.45–2.86 | 2.68 |
| *ferrugineus* ..... | 9 | 2.42–2.78 | 2.54 | 10 | 2.40–2.80 | 2.56 |

TABLE 52

*Neopulchellus* group (in part): W HEAD/W LEFT ELYTRON.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *obtusus* ..... | 3 | 0.98–1.06 | 1.03 | 17 | 0.95–1.04 | 1.00 |
| *anthracinus* T .... | 6 | 1.00–1.10 | 1.05 | 11 | 1.00–1.18 | 1.09 |
| *anthracinus* C .... | 4 | 1.00–1.10 | 1.04 | 8 | 1.03–1.17 | 1.08 |
| *ferrugineus* ..... | 9 | 1.10–1.17 | 1.13 | 10 | 1.06–1.21 | 1.13 |

TABLE 53

*Neopulchellus* group (in part): W LEFT ELYTRON/L HEAD.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *obtusus* ..... | 3 | 1.80–1.93 | 1.87 | 17 | 1.81–2.08 | 1.95 |
| *anthracinus* T .... | 6 | 1.82–2.08 | 1.93 | 11 | 1.75–2.04 | 1.86 |
| *anthracinus* C .... | 4 | 1.85–2.04 | 1.92 | 8 | 1.70–2.04 | 1.82 |
| *ferrugineus* ..... | 9 | 1.69–1.85 | 1.76 | 10 | 1.65–1.82 | 1.72 |

TABLE 54

*Neopulchellus* group (in part): L PN/L HEAD.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *obtusus* ..... | 3 | 1.93–1.96 | 1.95 | 17 | 1.83–2.12 | 1.97 |
| *anthracinus* T .... | 6 | 1.70–1.96 | 1.81 | 11 | 1.57–1.80 | 1.69 |
| *anthracinus* C .... | 4 | 1.75–1.88 | 1.82 | 8 | 1.55–1.78 | 1.69 |
| *ferrugineus* ..... | 9 | 1.60–1.81 | 1.70 | 10 | 1.55–1.78 | 1.64 |

TABLE 55

*Neopulchellus* group (in part): W PN WP/W HEAD.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *obtusus* ..... | 3 | 1.40–1.45 | 1.43 | 17 | 1.32–1.45 | 1.39 |
| *anthracinus* T .... | 6 | 1.23–1.35 | 1.31 | 11 | 1.20–1.34 | 1.28 |
| *anthracinus* C .... | 4 | 1.28–1.38 | 1.33 | 8 | 1.21–1.33 | 1.28 |
| *ferrugineus* ..... | 9 | 1.21–1.32 | 1.28 | 10 | 1.19–1.31 | 1.25 |

TABLE 56

*Neopulchellus* group (in part) and *B. flavipes laticeps* Blatchl.
PN: W BASE/W APEX.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *obtusus* ..... | 3 | 1.08–1.17 | 1.13 | 17 | 1.07–1.18 | 1.12 |
| *anthracinus* T .... | 6 | 1.08–1.17 | 1.14 | 11 | 1.00–1.10 | 1.07 |
| *anthracinus* C .... | 4 | 1.08–1.13 | 1.12 | 8 | 1.05–1.14 | 1.08 |
| *ferrugineus* ..... | 9 | 1.06–1.16 | 1.11 | 10 | 1.05–1.11 | 1.07 |
| *laticeps* ..... | 12 | 0.93–1.07 | 1.01 | 8 | 0.91–1.00 | 0.95 |

TABLE 57

*Neopulchellus* group (in part) and *B. flavipes laticeps* Blatchl.
PN: W BASE/L.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *obtusus* ..... | 3 | 1.06–1.13 | 1.10 | 17 | 1.07–1.18 | 1.12 |
| *anthracinus* T .... | 6 | 1.20–1.27 | 1.24 | 11 | 1.23–1.33 | 1.28 |
| *anthracinus* C .... | 4 | 1.17–1.26 | 1.22 | 8 | 1.17–1.30 | 1.25 |
| *ferrugineus* ..... | 9 | 1.18–1.31 | 1.24 | 10 | 1.20–1.33 | 1.26 |
| *laticeps* ..... | 12 | 0.96–1.10 | 1.02 | 8 | 0.96–1.09 | 1.01 |

## The *pulchellus* complex

The distinguishing characteristics of this complex are listed in a preceding section concerning the classification of the species of the subgenus. Representatives of this complex are not known from localities beyond the limits of the North American continent. The distribution pattern of the group as a whole is predominantly southern and eastern. None of the species occur in the Northern Coniferous forest as far as I know.

### *pulchellus* group

This group is represented by the single species, *Badister pulchellus* Le Conte, the major diagnostic features of which are presented in the section dealing with classification.

*B. pulchellus* is known to occur only in eastern North America, its northernmost locality being its type locality, Evanston, Indiana.

**Badister** (*s. str.*) **pulchellus** Le Conte

*Badister pulchellus* Le Conte, 1848: 418; [type specimen a male, in Le Conte Coll., MCZ No. 5720 (Lec No. 318); (male genitalia dissected by Lindroth, and glued to a card, with the specimen).]. Type locality: Evanston, Indiana; (determined from original description; type specimen labelled with a yellow disc, meaning "western states.").
Lindroth, 1954: 151-152.

*Description.*—Male Galesburg, Ill., (Stromberg Collection), [Illinois Natural History Survey Collection].

Length 4.75 mm., width 2.10 mm. Color: the following black—head, submentum, metasternum, small spot at apex on dorsal surface of hind and middle tarsal segments 1-4, median 1/3 and apical 1/4 of elytra, excluding intervals 1 and 9; clypeus and labrum piceous; antennal segments 4-11 varying from rufo-piceous to rufo-testaceous; apical segments of palpi rufo-piceous; tibiae and tarsi rufescent; the following orange-testaceous—antennal segments 1-3, prothorax, mesothorax, lateral sclerites of metathorax, and antecoxal piece, coxae, scutellum, basal 1/3 of elytra, intervals 1-9 throughout, a broad transverse band in apical 1/3 of elytra, and elytral epipleurae. Microsculpture approximately isodiametric on head and pronotum, the lines forming meshes, transverse on elytra, very close together, not forming meshes; dorsal surface of head and pronotum shining not iridescent, dorsal surface of elytra strongly iridescent.

Head average in all respects for the genus. Penultimate segment of maxillary palpus .64 times the length of the terminal segment. Eyes moderately prominent.

Pronotum as in fig. 121, discal impressions average; posterior lateral impressions irregular rather shallow basins.

Elytra with sides more broadly rounded, therefore less parallel than in *B. neopulchellus*; striae and intervals average for genus; left elytron as wide as head.

Male genitalia as in figs. 146a-d.

*Variation.*—I have seen two additional specimens of this species and will describe them briefly.

Male. Kosciusko Co., Ind. [Blatchley Collection Purdue University]. This specimen differs from the male described above in being slightly larger, 4.7 mm. long, slightly darker, with metepisternum infuscated (but distinctly paler than metasternum). Except for slight proportional differences, the two specimens are identical.

Female. " Tenn.", (Otto Lugger Collection), [University of Minnesota Coll.]. Length 4.82 mm., width 2.20 mm. Color as in the Illinois male, except that the antennae and terminal palpal segments are slightly paler, and the metepimera and lateral portions of the hind coxae are slightly infuscated. Retractile stylus as in fig. 161; 8th sternite as in fig. 160.

*Distribution.*—This species is known to me through the type and the three specimens described above. In addition, Lindroth (1954) records a single male collected at Selma, Alabama.

### *elegans* group

The distinctive features of this group are described in the section dealing with the classification of the species of this subgenus.

**Badister** (*s. str.*) **elegans** Le Conte

*Badister elegans* Le Conte, 1880:165; [type specimen a female, in Le Conte Coll., MCZ No. 5722, bearing a salmon pink label with the number 82 written on it.]. Type locality: Bosque County, Texas (Belfrage); (determined from original description).

The only other American species of Badister having a black pronotum and spotted elytra are *maculatus* and *vandykei*. If the characters presented in the key to species cannot be satisfactorily interpreted, see tables 60, 61, and 62 which contain data on variation in the ratios W head/W left elytron, W PN wp/L PN, and L PN/L head.

*Description of color and microsculpture.*—Male. Kingsville, Texas, (C. T. Reed), [Cornell University Coll.]. Elytra bicolored, orange in basal 1/3, and throughout length of sutural interval and epipleurae, and a preapical area ad-

joining suture and extending to stria 4, the rest of elytra black; the following black—head, prothorax (excluding margins), scutellum, and lateral and ventral sclerites of pterothorax, and hind coxae; the following rufous—labrum, clypeus, mandibles, terminal segment of labial palpus, and antennal segments 3-11; antennal scape, subterminal palpal segments, and femora testaceous, the tarsi and coxae slightly darker. Microsculpture of head and pronotum isodiametric, these structures shining, not iridescent; of elytra, transverse, lines very close together, surface strongly iridescent.

*Variation.*—The extent of black on the elytra varies from 3/4 to 7/8 of the total length of the elytra; the preapical orange testaceous spot usually terminates laterally in the vicinity of interval 4, but in one specimen examined extends to interval 5, and in another only as far as interval 3.

Data on variation in the following mensural characters and ratios are presented in tables 58-62—length, width, W head/W l. elytron, PN: W wp/L, and L PN/L head. *Elegans* seems to have a longer head and narrower pronotum than is characteristic of *maculatus.* The pronotum is as in fig. 122. Variation in the shape of the median lobe (figs. 147a-e) is inconsequential.

*Distribution.*—This species seems to be an inhabitant of the Great Plains, and possibly of the northern portion of the Mexican Plateau.

In addition to the type, I have seen twenty-two males and forty-two females collected in the following localities.

Arkansas: Hempstead County; Hope. Illinois: "Ill." Kansas: "Douglas County"; Lawrence. Missouri: Jackson County; Kansas City. Texas: "Tex." Bexar County; San Antonio. "Brazos County." Cameron County; Brownsville. El Paso County; El Paso. Kleberg County; Kingsville. Travis County; Austin. No Locality Data: One male, three females.

**Badister** (*s. str.*) **vandykei,** new species

The color pattern and prominent posterior angles of the pronotum will separate this species from all other North American members of the genus known to me. The presence of a feeble dorsal "hook" on the apex of the median lobe will separate the males of *B. vandykei* from the males of *B. maculatus* and *B. elegans,* the species which resemble this one with respect to color pattern.

*Description.*—Type, a male. 20 mi[les] N[orth] Comondu, L.[ower] Cal. [ifornia], VII.23.38, (Michelbacher and Ross), [California Academy of Sciences Coll.].

Length 6.05 mm., width 2.65 mm. Color: the following black—head, pronotum (excepting lateral margins), propleurae and basal portion of prosternum, apical 2/3 of elytra, beginning at stria 1 and extending almost to lateral margins; the following piceous—clypeus, mandibles, submentum, and median portion of abdominal sternites; the following rufous—labrum, lateral margins of pronotum, apical portion of prosternum, and proepimera; the following rufescent—antennae, lateral and ventral sclerites of pterothorax, scutellum, tibiae and tarsi; the following testaceous—coxae, trochanters, and femora; elytra, excluding the black portions, orange-testaceous. Microsculpture approximately isodiametric on head and pronotum, surfaces shining; transverse on elytra, the lines very close together, and surface iridescent.

Head 1.50 times wider than long, frontal impressions somewhat deeper than in *B. neopulchellus;* clypeus declivous, seta on left side in a narrow, ovate pit, that on right side arising from a more or less triangular depression; lobes of labrum decidedly divergent. Penultimate setment of maxillary palpus subequal to terminal segment. Eyes prominent, convex.

Pronotum as in fig. 124; disc broadly convex, medially flattened, laterally moderately declivous, sloping evenly and slightly downward posterio-medially, more abruptly so posterio-laterally to form posterio-lateral depressions; median longitudinal impression moderately deep, extending almost to anterior margin, ending far short of posterior margin; posterio-lateral impressions separated from lateral grooves by a very broadly and feebly elevated ridge, the impressions elongate, shallow basins.

Male genitalia as in figs. 149a-c.

**Badister** (*s. str.*) **maculatus** Le Conte

*Badister maculatus* Le Conte, 1880: 165; [type specimen a female, in Le Conte Coll., MCZ No. 5721]. Type locality: Lancaster, Pennsylvania, (S. S. Rathvon); (determined from original description; type specimen labelled with a pink disc—"Middle States").

The pronotum is black, and relatively short and broad as compared with other members of the genus which have a similar color pattern.

*Description of color and sculpture.*—Male. Atsion, [Burlington Co.], N.[ew] J.[ersey], [California Academy of Sciences Coll.]. The following are black—head, prothorax (excluding lateral margins), lateral and ventral sclerites of pterothorax, abdomen and hind coxae; elytra black as follows—basal 1/2 of interval 1, and area at base adjacent to prothorax, median 1/3 of elytra to stria 10, and apical 1/5 (excepting intervals 1 and 10), the two black areas joined by a narrow isthmus extending along interval 6; the following piceous—antennal flagellum (becoming progressively somewhat paler apically), fore and middle coxae; the following rufous—antennal pedicel, clypeus, medially, and labrum; elytra orange-testaceous, except for the black areas noted above; the following testaceous—palpi, antennal scape and legs. Microsculpture isodia-

metric on head and pronotum, these surfaces shining, lines very close together and transverse on elytra, the surface strongly iridescent.

*Variation.*—Color variation is slight, excepting the extent of the black areas of the elytra. This dark area varies from 1/3 to 1/4 of the total length of the elytra, the apical areas being completely obliterated in a female from Crescent City, Florida, and variable in size in the other specimens studied. Data on variation in the following mensural characters and ratios are presented in tables 58-62—length, width, PN: W wp/L, L Pn/L head, and W head/W l. el.

Median lobe as in figs. 148a-c.

*Distribution.*—This species is widespread but seems to be rare in eastern United States.

In addition to the type, I have seen two males and three females collected in the following localities.

Florida: Putnam County; Crescent City. Indiana: Vigo County. Ohio: Athens County; Athens. South Carolina: Dorchester County; Summerville.

TABLE 58

*Badister elegans, maculatus, and vandykei:* Total Length (mm.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *elegans* ..... | 20 | 5.08–5.98 | 5.38 | 20 | 4.95–5.85 | 5.32 |
| *maculatus* ..... | 2 | 5.05–5.72 | 5.38 | 4 | 5.28–5.80 | 5.60 |
| *vandykei* ..... | 1 | 4.90 | | | | |

TABLE 59

*Badister elegans, maculatus,* and *vandykei:* Maximum Width (mm.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *elegans* ..... | 20 | 2.00–2.45 | 2.27 | 20 | 2.08–2.45 | 2.29 |
| *maculatus* ..... | 2 | 2.30–2.60 | 2.45 | 4 | 2.42–2.60 | 2.49 |
| *vandykei* ..... | 1 | 2.22 | | | | |

TABLE 60

*Badister elegans, maculatus,* and *vandykei:* W head/W l. elytron.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *elegans* ..... | 20 | 0.96–1.07 | 1.01 | 20 | 0.96–1.07 | 1.01 |
| *maculatus* ..... | 2 | 1.06–1.07 | 1.05 | 4 | 1.06–1.20 | 1.10 |
| *vandykei* ..... | 1 | 1.02 | | | | |

TABLE 61

*Badister elegans, maculatus,* and *vandykei:* PN: W WP/L.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *elegans* ..... | 20 | 1.20–1.33 | 1.25 | 20 | 1.15–1.31 | 1.25 |
| *maculatus* ..... | 2 | 1.43–1.48 | 1.46 | 4 | 1.40–1.55 | 1.49 |
| *vandykei* ..... | 1 | 1.23 | | | | |

TABLE 62

*Badister elegans, maculatus,* and *vandykei:* L PN/L HEAD.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *elegans* ..... | 20 | 1.72–2.04 | 1.88 | 20 | 1.80–1.95 | 1.88 |
| *maculatus* ..... | 2 | 1.61–1.75 | 1.68 | 4 | 1.50–1.73 | 1.61 |
| *vandykei* ..... | 1 | 2.00 | | | | |

**Badister** (*s. str.*) **flavipes** Le Conte

In its external features, *flavipes* can be confused with the other concolorous species of the typical subgenus. Its iridescent elytra and darker color distinguish this species from *obtusus.* Body color is predominantly black in *flavipes flavipes, flavipes mexicanus,* and *ferrugineus anthracinus,* but the legs of the first two subspecies are testaceous in color, while those of *anthracinus* are piceous to black. The third named population of this species, *flavipes laticeps,* may be confused with the typical subspecies of *ferrugineus,* and *transversus* Casey. It may be separated from the former by its more elongate pronotum, with narrower base, and sides more sinuate posteriorly (see fig. 126; cf. fig. 119a), and its paler colored antennae (testaceous to slightly darker), and from the latter by the same pronotal characters (see tables 66-68 and fig. 126; cf. fig. 128), the lack of iridescence on the surface of the pronotum, and its proportionately wider head (table 65). The median lobe of this species most closely resembles the median lobe of *notatus,* but the dorsal sclerotized strips are appreciably wider basally than they are in *notatus.* (See fig. 150a-c; cf. fig. 151a-c.)

This species, as defined by me, is composed of three geographical races: a more northern subspecies, *laticeps,* ranging from New York, westward to Iowa in the Mississippi Basin, and southward at least into Texas. The typical subspecies is largely Gulf Coastal and Florid-

ian, and the third, *mexicanus* Van Dyke, is based on a single specimen from Oaxaca, Mexico.

I have seen six specimens from Louisiana, including the type of *flavipes*. Of these, one is like specimens from Florida (*flavipes*), three are typical *laticeps,* and two are intermediate between the Floridian specimens and *laticeps*. One of these two, unfortunately, is the type of *flavipes*. The Louisiana specimens which seem to exhibit features of both nominate forms, the fact that the males of *laticeps* and *flavipes* have identical genitalia, and the fact that these two forms are largely allopatric constitute my evidence for regarding these two forms as elements of a single species. A weakness in this treatment is that one specimen of *flavipes* has a " Kansas " locality label on it, an area which is well within the range of *laticeps*.

*Badister mexicanus* is included in this species because it is very similar to the two American subspecies and, indeed, appears to possess some of the characters of each.

A nomenclatorial problem arises in connection with the North American subspecies. If, as I believe, the type of *flavipes* is actually an intergrade between the two populations, then the intergrade specimens should rceive the subspecific trivial name, and the eastern Gulf Coastal and Floridian specimens should receive a new name. For the present, I prefer not to take this action as the evidence recommending it is more suggestive than conclusive.

**Badister flavipes flavipes** Le Conte

*Badister flavipes* Le Conte, 1853: 388; [type specimen a female, in Le Conte Coll., MCZ No. 3725]. Type locality: Louisiana; (determined from original description; type specimen labelled with orange disc—" southern states ").

The typical subspecies is predominantly black in color with a relatively narrow head (table 65), the pronotum with a relatively broad base (tables 67 and 68), and relatively broadly rounded posterior angles. The Mexican subspecies differs only in pronotal shape with posterior angles narrowly rounded and the sides slightly sinuate before them. The color of the dorsum of the more northern subspecies varies from rufo-piceous to black, its head is broader (table 65), pronotum with hind angles narrowly rounded, and base relatively narrow (tables 67 and 68).

*Description of color and sculpture.*—Male. G[eorgi]a; [Museum of Comparative Zoology]. The following black—head, thorax, elytra, abdomen, and hind coxae; the following rufous—labrum, clypeus, palpi, antennae, and fore and middle coxae; legs, excluding coxae, testaceous. Microsculpture of dorsal surface of head and pronotum approximately isodiametric, surfaces shining not iridescent, elytra with lines transverse very close together not forming an obvious mesh work, surface strongly iridescent.

*Variation.*—Head, thorax, and abdomen are invariably black in the specimens which I have examined; elytral epipleurae vary from rufous to piceous, usually dark rufous. The antennae are variably rufo-testaceous, the scape usually somewhat paler than the pedicel, and the first few segments of the flagellum. The flagellum becomes paler apically. The clypeus and labrum vary in color from rufo-piceous to rufo-testaceous, the labrum usually somewhat paler than the clypeus. The palpi vary from dark rufous to testaceous, the terminal segments generally darker medially than the subterminal segments. The ventral and lateral sclerites of the thorax are generally black, but vary from piceous through rufous in some specimens. The abdomen varies from all black to predominantly black, with the median area of each sternite rufous. The legs exhibit slight color variation, from testaceous to rufo-testaceous.

Data on variation in the following measurements and ratios are presented in tables 63-68—length, width, W head/W l. elytron, PN: W base/W apex, and PN: W base/L. The male genitalia are as in figs. 150a-c.

*Distribution.*—Details are presented above. In addition to the type, I have seen three males and nine females of this subspecies collected in the following localities.

FLORIDA: "Fla." Dade County; Homestead, Little River. Lee County; Fort Myers. Manatee County; Oneco. Orange County; Winter Park. Palm Beach County; Lake Worth. GEORGIA. KANSAS: Hamilton County. LOUISIANA.

**Badister flavipes laticeps** Blatchley, new combination

*Badister laticeps* Blatchley, 1910: 117-118; [type specimen, (sex undetermined), in Blatchley Coll. Purdue University.]. Type locality: Perry Co., Ind.[iana], 5.20.08; (determined from label on type specimen).

*Badister flavicornis* Casey, 1920: 208; **New synonymy;** type specimen a female, in Casey Coll., USNM No. 47368.]. Type locality: Cedar Rapids, Iowa; (determined from original description; label on type specimen reads "Ia.").

The diagnostic features of this geographical race are presented in conjunction with the diagnosis of the typical subspecies.

*Description of color and sculpture.*—Male. Clark Co[unty], Ind.[iana], 4.15.03, (WSB), [Blatchley Coll., Purdue University].

Head black; the following variously rufo-piceous—mandibles, thorax, elytra, abdomen, coxae; the following testaceous—palpi, femora, and scape of antennae; tibiae, tarsi, and antennal segments 2-11 more or less rufo-testaceous. Microsculpture of dorsal surface of head and pronotum approximately isodiametric, lines on elytra very fine, transverse, and very close together, the elytra strongly iridescent.

*Variation.*—The head varies from black to dark piceous. The clypeus varies from rufous to rufo-piceous, the labrum from rufous to rufo-testaceous. Antennae vary from testaceous to rufo-testaceous, the scape and pedicel and first few segments of flagellum testaceous, the rest rufo-testaceous. The type specimen of *flavicornis* Casey has the antennae testaceous throughout. The palpi vary from testaceous to rufo-testaceous (a male from Lemoyne, Pa.), through dark piceous to rufo-piceous (a female from St. Charles, Mo.), piceous on the average, with the lateral areas somewhat paler than the disc. The elytra vary about the same as does the pronotum, with epipleurae slightly paler, varying from rufous to rufo-testaceous. The lateral and ventral sclerites of the thorax and the abdomen are usually somewhat paler than the pronotum. The coxae are about the same color as the sternal sclerites, and the remaining sclerites of the legs vary from testaceous to rufo-testaceous.

The male and female genitalia are as in the typical subspecies.

Data on variation in the following measurements and ratios are presented in tables 63-68—length, width, W head/W l. el., W Pn wp/W head, PN : W base/W apex, and PN : W base/L.

*Synonymical Notes.*—Casey's species, *flavicornis,* is based on a specimen which differs from *laticeps* Blatchley only in having the median segments of the antennae paler in color. Otherwise the two are virtually identical. In the absence of other differentiating characters, I conclude that Casey's type specimen is nothing more than an extreme variant of this subspecies.

*Distribution.*—In addition to the type, I have seen thirteen males and eight females which were collected in the following localities.

Illinois: Knox County; Galesburg. Indiana: "Vigo County." Louisiana:

"La." NEW YORK: Tompkins County; Ithaca. MISSOURI: St. Charles County; St. Charles. OHIO: Franklin County; Columbus. "Sandusky County." PENNSYLVANIA: "Allegheny County." Cumberland County; Lemoyne. Perry County; N. Bloomfield. TEXAS: "Tex."

**Badister flavipes mexicanus** Van Dyke, new combination

*Badister mexicanus* Van Dyke, 1945: 102. Type locality: Oaxaca, Oaxaca, Mexico, (determined from original description and label on specimen).

The diagnostic features of this subspecies are presented in conjunction with the diagnosis of the typical subspecies.

*Description.*—Type, female. Oaxaca, Oax[aca], Mexico, VII.20.37, 5000′, (M. A. Embury), Van Dyke Collection, [California Academy of Sciences].

Female. Length 5.75 mm., width 2.55 mm. Color: head, thorax, elytra, and abdomen predominantly black; narrow side margins of pronotum and elytra, elytral epipleurae, fore and middle coxae, and apex of hind coxae rufous, clypeus somewhat darker; antennal scape and pedicel rufous, 3 and 4 rufo-piceous, excepting basal portion which is rufous, segments 5-11 with a median longitudinal rufo-piceous stripe, laterally rufo-testaceous, the stripe becoming progressively narrower and paler so that terminal segment is predominantly rufo-testaceous; legs testaceous, tibiae and tarsi somewhat darker than femora; palpi rufous, terminal segment of labial palpus rufo-piceous. Microsculpture as in typical subspecies, elytra iridescent.

Head 1.82 times wider than long, 1.02 times wider than left elytron. Eyes and maxillary palpi as in typical subspecies.

Pronotum cordate, 1.27 times wider than head, 1.41 times wider than long, 1.32 times wider at widest point than at apex, 1.27 times wider at widest point than at base, base 1.20 times wider than apex, and 1.10 times greater than median length; anterior margin broadly concave, sides arcuate anteriorly, evenly constricting posteriorly, the posterior angles obtuse; posterior impressions moderately deep, confluent with narrow lateral grooves, prosternum finely rugulose laterally.

Elytra 1.57 times wider than pronotum, 1.53 times longer than wide, sides almost straight and feebly divergent to apical 1/4, then gradually rounded and barely perceptibly sinuate to apex; striae complete and well impressed, intervals flat.

This specimen is compared with the other two subspecies in the discussion of variation of the typical subspecies.

My description disagrees slightly with the original with respect to size and proportions. This species was thought by its describer to be most closely related to "our well known *Badister micans* Lec," (presumably 1848, *ocularis* Casey, 1920). The latter species is in the subgenus *Baudia* and is structurally not at all close to *mexicanus*.

TABLE 63

*Badister flavipes* and *transversus:* TOTAL LENGTH (MM.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *f. flavipes* ..... | 2 | 5.55–5.95 | 5.75 | 10 | 5.25–6.05 | 5.60 |
| *f. mexicanus* ..... | | | | 1 | 5.75 | |
| *f. laticeps* ..... | 13 | 5.10–6.22 | 5.86 | 8 | 5.50–6.38 | 5.85 |
| *transversus* ..... | 9 | 5.10–5.70 | 5.55 | 18 | 5.18–6.00 | 5.63 |

TABLE 64

*Badister flavipes* and *transversus:* MAXIMUM WIDTH (MM.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *f. flavipes* ..... | 2 | 2.45–2.52 | 2.48 | 10 | 2.20–2.65 | 2.47 |
| *f. mexicanus* ..... | | | | 1 | 2.55 | |
| *f. laticeps* ..... | 13 | 2.18–2.65 | 2.43 | 8 | 2.20–2.70 | 2.40 |
| *transversus* ..... | 9 | 2.15–2.55 | 2.45 | 18 | 2.15–2.55 | 2.45 |

TABLE 65

*Badister flavipes* and *transversus:* W HEAD/W LEFT ELYTRON.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *f. flavipes* ..... | 2 | 1.00–1.02 | 1.01 | 10 | 0.98–1.08 | 1.03 |
| *f. mexicanus* ..... | | | | 1 | 1.02 | |
| *f. laticeps* ..... | 12 | 1.04–1.16 | 1.10 | 8 | 1.11–1.23 | 1.16 |
| *transversus* ..... | 9 | 0.96–1.06 | 1.01 | 18 | 0.97–1.09 | 1.04 |

TABLE 66

*Badister flavipes* and *transversus:* PN: W WP/W HEAD.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *f. flavipes* ..... | 2 | 1.26–1.40 | 1.33 | 10 | 1.20–1.30 | 1.27 |
| *f. mexicanus* ..... | | | | 1 | 1.27 | |
| *f. laticeps* ..... | 12 | 1.20–1.33 | 1.25 | 8 | 1.16–1.24 | 1.21 |
| *transversus* ..... | 9 | 1.35–1.42 | 1.38 | 18 | 1.30–1.41 | 1.36 |

TABLE 67

*Badister flavipes* and *transversus:* PN: W BASE/W APEX.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *f. flavipes* ..... | 2 | 1.10–1.18 | 1.14 | 10 | 1.04–1.19 | 1.12 |
| *f. mexicanus* ..... | | | | 1 | 1.20 | |
| *f. laticeps* ..... | 12 | 0.93–1.07 | 1.01 | 8 | 0.91–1.00 | 0.95 |
| *transversus* ..... | 9 | 1.08–1.16 | 1.12 | 18 | 1.04–1.15 | 1.09 |

TABLE 68

*Badister flavipes* and *transversus:* PN: W BASE/L.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *f. flavipes* ..... | 2 | 1.10–1.13 | 1.12 | 10 | 1.02–1.15 | 1.08 |
| *f. mexicanus* ..... | | | | 1 | 1.10 | |
| *f. laticeps* ..... | 12 | 0.96–1.10 | 1.02 | 8 | 0.96–1.09 | 1.01 |
| *transversus* ..... | 9 | 1.12–1.24 | 1.18 | 18 | 1.10–1.21 | 1.15 |

**Badister** (*s. str.*) **notatus** Haldeman

*Badister notatus* Haldeman, 1843: 299. Type locality: not given in the original description.

*Badister terminalis* Le Conte, 1844: 51; [type specimen a male, in Le Conte Coll.]. Type locality: New York; (determined from original description; type specimen labelled with a pink disc—"middle states").—Le Conte, 1848: 317.

*Badister gilvipes* Casey, 1920: 207; **New synonymy;** [type specimen a female, in Casey Coll., USNM No. 47366]. Type locality: Long Island, New York, (5.4.02); (determined from type specimen and original description).

*Badister angustus* Casey, ibid.; **New synonymy;** [type specimen a male, in Casey Coll., USNM No. 47367]. Type locality: Illinois; (determined from original description, and label on type specimen).

This species is quite distinctive, but on the basis of genitalic characters of both the males and females, *Badister notatus* is definitely a member of the *elegans* group, and in the structure of the median lobe is very similar to *flavipes.* (See figs. 151a-c; cf. figs. 150a-c.)

*Description of color and sculpture.*—Male. North Cumberland, Pennsylvania IV.3.10, (Kirk and Champlain), [Bureau of Plant Industry Coll., Harrisburg, Pa.]. The following black—head, pronotum, excepting base, proepipleurae, and lateral and ventral sclerites of pterothorax; the following piceous—prosternum, abdomen, and hind coxae; the following rufo-piceous—mandibles, fore and mid-

dle coxae, base of pronotum and elytra, including epipleurae; the following rufous—antennal segments 4-11, tibiae, tarsi, and scutellum; the following rufotestaceous—antennal segments 1-3, palpi and femora. Microsculpture on front of head very faint, appearing more as small punctures, very fine on posterior portion of head, isodiametric, more transverse on ventral surface of head; surface shining; surface of pronotum smooth, without a trace of microsculpture, shining; strongly transverse on elytra, the lines very close together, surface iridescent.

*Variation.*—Length: males, 3.82-4.55 mm. (4.19 mm.); females, 3.78-4.65 mm. (4.19 mm.). Width: males, 1.55-1.95 mm. (1.71 mm.); females, 1.60-1.90 mm. (1.72 mm.). Color exhibits slight and non-geographical variation; the humeral spot of the elytron is usually small, and slightly paler than the rest of the elytron, sometimes becoming considerably paler and sometimes covering the basal half of the elytron. The penultimate segment of the maxillary palpus is always greater than 1/2 but less than 3/4 the length of the terminal segment. The head usually is slightly wider than a single elytron. The hind angles of the pronotum vary from moderately to slightly rounded. The rugosity of the prosternum varies somewhat, but is clearly evident in all the specimens which I have examined. Eighty four exhibited vestigial hind wings. A single female, collected at Olcott, New York, had its hind wings fully developed. The male genitalia (figs. 151a-c) do not exhibit any appreciable variation.

*Synonymical Notes.*—I have seen the type specimens of *angustus* and *gilvipes* Casey, and have concluded that they are nothing more than specimens of *Badister notatus.* The diagnostic characters presented, such as relative head size, length of antennal segments, and body proportions, represent merely individual points in a slightly graded series of variation, and are therefore of little consequence from a taxonomic point of view. I did not dissect the types.

*Distribution.*—This species ranges on the Atlantic Coast from eastern Ontario southward to "North Carolina," westward across Ohio to Iowa, and southward in the Mississippi Basin to Kansas. I have seen thirty-eight males and fifty-six females collected in the following localities.

ARKANSAS: "Ark." DISTRICT OF COLUMBIA: "D. C." GEORGIA: Rabun County; Clayton. ILLINIOS: "Ill." Cook County; Chicago, Lyons. Knox County; Galesburg. INDIANA: "Crawford County." "Lake County." "Marion County." "Posey County." IOWA: "Ia." Henry County; Mt. Pleasant.

Johnson County; Iowa City. "Lee County." Scott County; Davenport. KANSAS: "Douglas County." Pottawatomie County; Onaga. "Riley County." Shawnee County; Topeka. MICHIGAN: "Mic." MISSOURI: "Mo." NEBRASKA: "Nebr." NEW JERSEY: "N. J." "Camden County"; Camden. NEW YORK: "N. Y." Albany County; Delmar. Kings County; Brooklyn. Nassau County; Great Neck, L. I. New York County; New York City. Niagara County; Olcott. Saratoga County; Saratoga Springs. Tompkins County; Ithaca, McLean Bogs. County not determined; North Beach L. I. NORTH CAROLINA: "N. C." ONTARIO: "E. Ont." Carleton County; Ottawa. PENNSYLVANIA: "Pa." Armstrong County; Schenley. Cumberland County; N. Cumberland. Dauphin County; Harrisburg. Delaware County; Darby. Northampton County; Easton. Philadelphia County; Philadelphia. RHODE ISLAND: WEST VIRGINIA: "W. Va." NO LOCALITY DATA: Two males, one female.

Subgenus **Trimorphus** Stephens

*Trimorphus* Stephens, 1828:180; [included species—*Trimorphus scapularis* Steph., and *Trimorphus confinis* Steph.].

GENOTYPE: *Trimorphus scapularis* Stephens (= *Badister sodalis* Duftschmid); (designated by J. O. Westwood, 1838:5).

The members of this subgenus share certain of the diagnostic features of the other two subgenera, as is noted in the discussion of subgeneric classification.

*Distribution.*—Members of this group are known to occur only in the western Palaearctic, southward to the island of Corsica in the Mediterranean, and eastward to Iran. In the Nearctic, the subgenus *Trimorphus* is represented in the lowlands of the northeast.

**Badister (Trimorphus) transversus** Casey

*Badister transversus* Casey, 1920:218; [type specimen a male, in Casey Coll., USNM No. 473711]. Type locality: probably Indiana (fide Casey), Levette coll; (determined from original description; type specimen labelled "L.").

The strong iridescence of the surface of the pronotum is the best single external diagnostic character of this species.

*Description of color and sculpture.*—Male. Arlington, [Suffolk Co.], Mass[achusetts], V.16.25, (Darlington; treading), [Cornell University Coll.]. Generally piceous except as follows: labrum and clypeus and margins of pronotum and elytra rufo-testaceous, basal segments of palpi testaceous, antennal scape testaceous basally becoming rufo-piceous apically, flagellum piceous to rufo-piceous apically, legs rufo-testaceous, coxae and epipleurae rufo-piceous. Microsculpture: head—dorsal surface approximately isodiametric, surface shin-

ing but not iridescent; pronotum and elytra—lines of microsculpture transverse, very close together, not forming obvious meshes, surface of both strongly iridescent.

*Variation.*—See tables 63 and 64 for data on variation in length and width. Color varies slightly as follows: clypeus and labrum always about the same color in a single specimen, vary from the "normal" rufo-testaceous to rufo-piceous in a single female from Dorchester, Mass. The palpi vary from testaceous to rufo-piceous, the basal segments always paler than the terminal segments, and the antennae show about the same range of variation. The scape is usually paler basally than apically. The lateral and ventral thoracic sclerites are always slightly paler than the pronotum, and the pronotum varies from piceous to rufo-piceous. The elytra exhibit about the same range of variation in color and are always of about the same color in a given specimen. The epipleurae vary from rufous to rufo-testaceous and are always paler than the dorsal surface of the elytra. The abdomen varies from dark piceous to rufous, being piceous on the average.

The pronotum (fig. 128) varies slightly in shape, the sides usually slightly sinuate posteriorly, but this sinuation is lacking in a few specimens.

Because it is conceivable that this species may be confused, on the basis of external characters, with the northern subspecies of *Badister flavipes, B. transversus* is compared with the former species with respect to a series of ratios which may be helpful in distinguishing between these nominate forms. Data on variation in the following ratios are presented in tables 65-68 which accompany the description of *Badister flavipes* Le Conte—W head/W l. elytron, PN: W wp/W head, PN: W base/W apex, PN: W base/L.

The male genitalia (figs. 152a-c) do not exhibit any appreciable variation. The 8th sternite and retractile stylus of the female are illustrated (figs. 162 and 163).

*Synonymical notes.*—The specimen labelled as type of *Badister micans* in the Le Conte collection is a member of this species, so possible *micans* and *transversus* are synonymous. However, I doubt this for reasons presented in the discussion of the synonymy of *Badister* (*Baudia*) *ocularis* Casey.

*Distribution.*—This species seems to be primarily northeastern in distribution, ranging from Quebec southward to Long Island on the East Coast, and westward to Indiana.

In addition to the type, I have seen nine males and sixteen females collected in the following localities.

CONNECTICUT: Litchfield County; Cornwall. INDIANA: Elkhart County; Elkhart. "Kosciusko County." MAINE: County not determined; Wales. MASSACHUSETTS: "Mass." Suffolk County; Arlington, Dorchester. NEW HAMPSHIRE: Rockingham County; Exeter. NEW JERSEY: Hudson County; Arlington. NEW YORK: Cayuga County; Howland Island. Tompkins County; Ithaca. Wayne County; Crusoe Lake. County not determined; North Beach L. I. OHIO: Ashtabula County; Jefferson. QUEBEC: Como, Montreal.

### Subgenus **Baudia** Ragusa

*Baudia Ragusa,* Nat. Sicil., Vol. VII, p. 3, 1884.

GENOTYPE: *Carabus peltatus* Panzer; (indicated as such by Jeannel, 1942: 1004).

The diagnostic features of this group are presented in the key, and following the description of the typical subgenus. Following are features which are shared in common by the North American species and which are therefore not repeated in the species descriptions.

Head piceous, or black, the remainder of the body piceous, except as noted below. The following are usually rufo-testaceous: scape, clypeus, lateral margins of pronotum and elytra, pronotal and elytral epipleurae, apex of pro- and mesosternum, antecoxal piece, median portion of the hind coxae, and adjacent areas of first abdominal sternite. The following are more or less testaceous: labrum, mouth parts, excluding mandibles (frequently the terminal segments of palpi are rufo-piceous, or darker), and legs.

Microsculpture and iridescence: dorsal surface of head variable; pronotum, microsculpture usually strongly and uniformly transverse, iridescence always apparent, but varying in intensity; elytra, microsculpture strongly transverse, the lines very close together, not forming an obvious mesh-work, when viewed at a magnification of 54 dia.; strongly iridescent; ventral surface of head, microsculpture transverse, lines moderately close together, iridescence weak; prosternum with transverse microsculpture, lines closer together medially than laterally; proepisternum with longitudinally directed lines about as far apart as on the sides of the prosternum, forming an obvious mesh work, except along dorsal margin where the lines are very close together; mes- and metepisterna with lines of microsculpture very close together and transverse, slightly farther apart on meso- and metasternum, forming an obvious mesh-work on the latter; ventral and lateral thoracic sclerites moderately to weakly iridescent; abdomi-

nal sternites strongly iridescent, the lines of microsculpture very fine, transverse, and very close together.

Palpi as described for the typical subgenus, except that the terminal segment of the maxillary palpus is always longer than the penultimate segment.

Pronotum more or less cordate, median longitudinal impression moderately impressed, anterior and posterior transverse impressions weakly indicated, posterior lateral impressions ovate, moderately deep, may or may not be joined with the lateral grooves; lateral grooves narrow anteriorly, widening posteriorly; lateral margins narrowly reflexed anteriorly, more strongly reflexed posteriorly.

Elytra with humeri rounded, sides diverging very slightly to apical 1/3-1/4, parallel for a short distance, then gradually rounded to the sutural angles; sutural angles acute, sharp.

Male genitalia: lateral sclerotized strips of median lobe arising from the apex of the basal bulb; dorsal apical plate of internal sac with dorsal margin straight, not concave in lateral aspect, and lacking a basal projection.

Female retractile plates: as figured (8th sternite, fig. 164; stylus, fig. 165).

### *Key to the North American Species of the Subgenus Baudia*

1. Vertex of head behind eyes not iridescent ..... 2
   Vertex of head behind eyes distinctly iridescent, laterally and posteriorly ..... *B. grandiceps* Casey
2. Basal 1/3-1/2 of elytra not distinctly paler than apical 1/2-2/3 ..... 3
   Basal 1/3-1/2 of elytra distinctly paler than apical 1/2-2/3 ..... *B. parviceps* n. sp.
3. Apex of mandibles truncate, total length less than 4.5 mm. ..... 4
   Apex of mandibles oblique, total length greater than 4.5 mm. ..... *B. ocularis* Casey
4.[8] Pronotum with sides strongly and abruptly incurved posteriorly, (fig. 133); distribution—California ..... *B. submarinus* Motschoulsky
   Pronotum with sides less strongly incurved posteriorly, posterior angles slightly rounded; distribution—United States, east of the Rocky Mountains, and Greater Antilles ..... *B. reflexus* Le Conte

[8] This couplet is admittedly unsatisfactory, but I know *B. submarinus* only from the type specimen, and the only differences I observed between it and *B. reflexus* are those presented above.

## Classification of the North American Species of the Subgenus *Baudia*

The North American species of *Baudia* can be divided into two clear-cut groups on the basis of genitalic characters. The *grandiceps* group includes *grandiceps* Casey, *parviceps* n. sp., and *ocularis* Casey, and is thus characterized: vertex of head iridescent or not, if so, iridescence is predominantly reddish-purple and occurs laterally and posteriorly, not medially; apex of median lobe of male genitalia with a ventrally directed spine, entire apical portion not bent ventrally; median dorsal sclerotized strip absent; dorsal apical plate of internal sac as heavily sclerotized as ventral plate, not arched in lateral aspect, lacking a distinct base, ventral plate without a lobate process on right margin, formed by a deep, narrow emargination of apical margin, a spine present on either the dorsal or ventral apical plate; one or two preapical plates present; in the case of the single plate this may either extend across the entire dorsal surface or be restricted to the left side (figs. 154-158). The second group, the *reflexus* group, includes only *reflexus* Le Conte. Vertex of head not iridescent, median lobe of male genitalia with apex reflexed ventrally, lacking an apical spine; median sclerotized strip present, dorsal apical plate of internal sac not as heavily sclerotized as ventral apical plate, not arched in lateral aspect, without a distinct base, ventral apical plate without a lobate process; both plates without spines; preapical plates absent (figs. 153a-e).

The Palaearctic species are characterized individually, but represent a single group. *A. peltata* possesses the following features: vertex of head not iridescent, apex of median lobe with a ventrally directed spine; median dorsal sclerotized strip absent; dorsal apical plate of internal with a distinct basal portion, ventral plate lobate on right side, sac as heavily sclerotized as ventral plate, apical plates without spines; a single small preapical plate at base of dorsal plate, on right side. These features are characteristic of *B. dilatatus:* vertex of head strongly iridescent, reddish-purple laterally, blue medially; apex of median lobe not recurved or spinose, but with a well developed preapical spine on ventral surface, median dorsal sclerotized strip absent; dorsal apical plate as heavily sclerotized as ventral plate, arched in lateral aspect, with a distinct base which lies in a different plane from the main portion of the plate; ventral plate lobate on right margin; apical plates without spines; two preapical plates, the right larger, the left smaller.

*reflexus* group

The diagnostic features of this species group are presented in the foregoing discussion.

**Badister (Baudia) reflexus** Le Conte

*Badister reflexus* Le Conte, 1880: 165, 166; [A type specimen was not designated in the original description. The specimens comprising the type series are from "New York, Michigan, and Louisiana." The type series, in the Le Conte collection, consists of four specimens, labelled as follows: specimen No. 1 MCZ No. 5727, with a pink disc beneath the specimen—"middle states"; specimen No. 2 labelled "Mich.", No. 3 bearing an orange disc—"southern states;" and specimen No. 4 labelled "La." I accept the first specimen of the series as type. Because Le Conte gives New York as the locality for one of his specimens in the original description, and because his concept of the "middle states" includes New York, I assume that this specimen which is from the middle states is the one that was taken in New York. Therefore, the type locality of this species is New York]. Blatchley, 1922: 12.

*Badister seclusus* Blatchley, ibid., (1922); Dunedin, Fla. March 10-April 19. [Two specimens taken by sweeping ferns in a dense hammock.] Type locality: Dunedin, Florida. [I have not seen the type.]

The broadly recurved apex of the median lobe, the absence of a preapical plate and the absence of a spine on the apical plates are the principal diagnostic features of this species (figs. 153a-c).

*Description of sculpture.*—Male. W.[est] Roxbury, [Suffolk Co.], Mass. [achusetts], May 20, 1923, (Bolster), [Museum of Comparative Zoology]. Microsculpture: head, uniformly isodiametric over entire dorsal surface, shining, vertex not iridescent; pronotum, generally strongly transverse, the surface in large measure iridescent, excepting medio-anteriorly and posteriorly. where the lines are far enough apart to form obvious meshes, and iridescence is not apparent.

*Variation.*—Data on variation in length, width, W head/total L, W head/W elytron, W head/L Pn, L Pn/total L, and l. shaft m.L/L left paramere are presented in the tables 69-75. Variation in the configuration of the sides of the pronotum is discussed below under synonomy. The male genitalia are constant with respect to features of diagnostic importance.

*Synonymical notes.*—The original description of *Badister seclusus* was based on two specimens, collected at Dunedin, Florida. I have not seen the type specimens. Dr. P. J. Darlington, Jr. loaned me a specimen identified by Blatchley as *seclusus* whose characters fit those men-

tioned in the original description, and which I therefore regard as a satisfactory substitute for the type. This specimen, a male, collected at Homestead, Florida, June, 1929 (Darlington), differs from the specimens representing *reflexus* only in having a proportionately wider head (*reflexus,* W head/total length—mean 0.23, *seclusus*—0.25), and a somewhat broader pronotum. The genitalia are identical with those of specimens which represent *reflexus.* The type specimens of *seclusus* were distinguished from *reflexus* as follows: " The basal side margins of thorax are much more strongly widened and inflexed than in *reflexus,* the hind angles more distinct ". These features are variable, and the specimens examined by me seem to fall into a graded series with respect to them. Specimens from Arkansas and Louisiana match almost exactly the specimen of *seclusus.* A male from Royal Palm Park, Florida, differs from the Homestead specimen only in that the sides of the pronotum are little more incurved posteriorly, and a little less reflexed. A specimen labelled " Florida " has a virtually identical pronotum with that of the Homestead specimen except that the posterior angles are less prominent. A specimen from Winter Park, Fla. is about the same as the Homestead specimen with respect to pronotal characters. A specimen from " Mass." has the same pronotal characters as those of the Homestead specimen. Other specimens, which are not listed here, differ more from the Homestead specimen, in the way mentioned by Blatchley, than those mentioned above. As the genitalia of " typical " *reflexus* and my single specimen of *seclusus* are identical, we are apparently left with the relatively broad head as the only feature of diagnostic value. As the value of this ratio for *seclusus* exceeds the observed range of variability for *reflexus* by only 0.01, and the series studied is small, I regard the difference as inconsequential.

*Distribution.*—This species ranges on the Atlantic Coast from Massachusetts southward to southernmost Florida and the Greater Antilles; eastward on the mainland to Indiana in the north, and along the Gulf Coast in the south to Texas. Its distribution in the Appalachians is unknown, if the species occurs there at all.

In addition to the type, fifteen males and twenty females collected in the following localities have been examined.

ARKANSAS: " Ark." Hempstead County; Hope. FLORIDA: " Fla." Dade County; Royal Palm Park. Lee County; Fort Meyers. Leon County; Talla-

hasee. "Marion County." Orange County; Winter Park. Palm Beach County; Pahokee. GEORGIA: "Ga." ILLINOIS: "Illinois." INDIANA: "Knox County." "Laporte County." "Marion County." "Marshall County." LOUISIANA: "La." MASSACHUSETTS: "Mass." Middlesex County; Wayland. Suffolk County; Cambridge, Dorchester, W. Roxbury. OHIO: "Ohio." Athens County; Athens. TEXAS: "Tex." NO LOCALITY DATA: one male, one female.

## the *grandiceps* group

The diagnostic features of this group are presented in the discussion of classification of the species of *Baudia.*

**Badister (Baudia) grandiceps** Casey

*Badister grandiceps* Casey, 1920: 207; [type specimen a female, in Casey Coll., USNM No. 47369]. Type locality: Washington, D. C.

The iridescence on the vertex of the head readily separates *Badister grandiceps* from all of the other North American species of this subgenus.

*Description of sculpture.*—Male. Arlington, [Hudson Co.], N.[ew] J.[ersey], (Schott), [California Academy of Science Coll.].

Microsculpture: head, isodiametric anteriorly, posteriorly becoming finer and more transverse in the area of the posterior pair of setigerous punctures, this area with violaceous iridescence, behind this band head again black, and microsculpture again approximately isodiametric; pronotum, microsculpture very fine, the lines parallel and transversely directed, essentially uniform throughout, iridescence strong.

*Variation.*—Data on variation in length, width, W head/total length, W head/W elytron, W head/L Pn, L Pn/total L, and l. shaft m.L/L left paramere are presented in tables 69-75. The vertex is iridescent in all specimens examined, but varies slightly in extent and intensity. The apical margin of the mandibles varies from truncate to somewhat oblique, not as strongly oblique, however, as in the mandibles of *ocularis* Casey. The pronotum exhibits slight variation in relative proportions, larger specimens having the pronotum more transverse (thus resembling *ocularis*), smaller specimens having the pronotum apparently more slender and elongate. The male genitalia are constant with respect to features of diagnostic importance (figs. 155a-c).

*Distribution.*—A transcontinental species, *Badister grandiceps,* is known from Washington and British Columbia, to South Dakota and Iowa, in the plains, eastward to Massachusetts on the east coast and southward to New Jersey.

In addition to the type, fifteen males and eighteen females collected in the following localities have been examined.

BRITISH COLUMBIA: Pender Harbor. CONNECTICUT: County not determined; Lyme. IOWA: "Dickinson County." MASSACHUSETTS: Middlesex County; Concord. Suffolk County; W. Roxbury. County not determined; Drac. MICHIGAN: "Mic." Marquette County; Huron Mtn. Club. NEW HAMPSHIRE: Rockingham County; Exeter. NEW JERSEY: "N. J." Hudson County; Arlington. NEW YORK: Cayuga County; Howland I. Cortland County; McLean Bogs. Tompkins County; Ithaca. ONTARIO: Trenton. QUEBEC: Arnprior, Como. SOUTH DAKOTA: "S. D." UTAH: County not determined; Utah Lake. WASHINGTON: Snohomish County; Everett.

**Badister (Baudia) parviceps,** new species

In addition to the characters presented in the key, this species may be distinguished from its congeners by its relatively narrow head, more elongate pronotum with somewhat wider base, and the lines of microsculpture sufficiently far apart so that a meshwork pattern is quite evident, especially near the median longitudinal impression. Iridescence of the pronotum is therefore weaker than in the other North American members of the subgenus. The male genitalia are more like those of *grandiceps* than of other members of the subgenus.

*Description.*—Type, male. Crusoe Lake, Wayne Co.[unty], N.[ew] Y.[ork], VI.14.33, (C. R. Crosby), [Cornell University Coll.].

Male. Length 3.95 mm., width 1.65 mm.; elytra rufo-piceous in basal 1/2, piceous in apical portion. Microsculpture: approximately uniformly isodiametric over entire dorsal surface, shining, vertex not iridescent; pronotum, as described in diagnosis above.

Head 1.78 times wider than long, 0.21 times in width the total length, 0.97 times the length of the pronotum, 1.04 times wider than left elytron. Apices of mandibles truncate. Eyes convex, moderate in size.

Pronotum as in fig. 132. Elytra 1.40 times wider than pronotum, 1.57 times longer than wide.

Male genitalia: as in figs. 156a-e.

*Variation.*—Data on variation in size and in diagnostically useful proportions are presented in tables 69-75. The pronotum varies from slightly to moderately transverse, the sides from moderately to weakly incurved posteriorly. The male genitalia do not exhibit apreciable variation in features of diagnostic importance.

*Distribution.*—This species ranges from Washington, D. C. and Connecticut, on the east coast, westward through eastern Ontario and

New York to Minnesota and Kansas, in the Great Plains.

Paratypes: thirteen males and twenty-three females collected in the following localities.

CONNECTICUT: Litchfield County; Canaan, Cornwall. DISTRICT OF COLUMBIA: "D. C." ILLINOIS: "Ill." Champaign County; Urbana. INDIANA: "Vigo County." IOWA: "Ia." KANSAS: "Douglas County"; Lawrence. MARYLAND: "Md." County not determined; Plummers Is. MINNESOTA: "Olmsted County." NEW YORK: Cayuga County; Howland Is. County not determined; Meadowdale. ONTARIO: "E. Ont."

These specimens are in the collections of the following institutions: Academy of Natural Sciences of Philadelphia; Bureau of Plant Industry, Harrisburg, Pennsylvania; California Academy of Sciences; Cornell University; Department of Agriculture, Ottawa, Ontario; Museum of Comparative Zoology; Purdue University (Blatchley Coll.); University of Kansas; University of Minnesota.

**Badister (Baudia) ocularis** Casey

*Badister micans* Le Conte, 1848:318; (not *Badister micans* Le Conte, 1844). [Type specimens, a female from Georgia, and a male from Long's Peak, [Colorado?], according to the original description. This species is represented by four specimens in the Le Conte collection: the "type," a female labelled with a pink disc, "middle states," MCZ No. 5726, (*Badister transversus* Casey); a specimen from Cambridge, Mass?, sex undetermined, (*Badister transversus* Casey); a male labelled with an orange disc, "southern states," (*Badister ocularis* Casey); and a male labelled with a green disc, "Nebraska etc.," another species of *Baudia*, which I did not determine]. Type locality: Georgia (here selected). Casey, 1920:206.

*Badister ocularis* Casey, 1920:210; [type specimen a female, in Casey Coll., USNM No. 47370]. Type locality: Ill.[inois].

This species is most easily confused with the larger specimens of *Badister grandiceps*, but lacks the iridescence on the vertex of the head. A combination of relatively large size (length over 4.5 mm.), broad head, and strongly iridescent pronotum separate *ocularis* readily from the other Nearctic members of this subgenus.

*Description of microsculpture.*—Male. N.[orthern] Ill[inois], [Illinois Natural History Survey]. Length 4.95 mm., width 2.00 mm. Head approximately uniformly isodiametric over entire dorsal surface, shining, not iridescent; pronotum strongly transverse, the lines very fine and very close together, strongly iridescent.

*Variation.*—Data on variation in size and diagnostically useful proportions are presented in tables 69-75. The sides of the pronotum vary from strongly to moderately incurved posteriorly, posterior angles always well formed, and on the average the base is wider than in *grandiceps.* Male genitalia are constant with respect to diagnostic features (figs. 153a-g.).

*Synonymical notes.*—As Casey pointed out (1920:206), Le Conte's original description of *Badister micans* does not coincide with his later description applied to the same species. The specimens labelled as *micans* in the Le Conte collection fit approximately Le Conte's second (1848) description. The specimen labelled as type, which I examined at the Museum of Comparative Zoology, was collected in the " middle states ", and is a representative of *Badister transversus* Casey. The specimens mentioned by Le Conte in his 1848 description were a male collected on Long's Peak, and a female from Georgia. Neither of these localities is in the " middle states ", and so the specimen which at present bears the type label is not one of those mentioned in Le Conte's description. As far as I know, *Badister transversus* Casey has not been collected in Georgia, so I doubt that Le Conte had a specimen of this species before him. The only specimen in the series which could have been collected in Georgia is a male, a specimen of *Badister ocularis* Casey, taken in the " southern states ". But this specimen probably was not mentioned in the O.D. either, because the Georgia cotype was a female. At least the two coincide in a general way, with respect to locality, and might be representative of the same species. Additional evidence bearing on the possible identity of the Le Conte Georgia cotype is a series of *Badister ocularis* in the Horn Collection, at the Academy of Natural Sciences of Philadelphia, labelled " Ga." and determined as *Badister micans* Le Conte.

I agree with Casey that the name *Badister micans* as originally used applies to a species which is certainly different from the second species to which Le Conte applied the name, and is probably not a *Badister* at all. If this is true, then the name *B. micans* Le Conte, 1848, is based on a misidentification of *B. micans* Le Conte, 1844, and the species to which the former name was applied is, in reality, unnamed. To this biological entity, Casey has applied the name *Badister ocularis.*

Possibly the name *Badister micans* LeC. 1844 applies to some small harpaline, as the original description states that there is " an impressed point near each eye ", a characteristic feature of the Tribe Harpalini, but not of the North American Licinini.

*Distribution.*—The series of specimens which I have seen has been collected in localities in the Atlantic coastal states, from southern Quebec, southward to Georgia, and westward to Illinois.

In addition to the type, twelve males and sixteen females collected in the following localities have been examined.

CONNECTICUT: County not determined; Lyme. GEORGIA: " Ga." ILLINOIS: " N. Ill." INDIANA: " Knox County." MASSACHUSETTS: " Mass." Hampden County; Wales. Suffolk County; Arlington, Brookline, Cambridge, W. Roxbury. NEW YORK: Niagara County; Olcott. Tompkins County; Ithaca. Westchester County; Peekskill. ONTARIO: County not determined; Trenton. PENNSYLVANIA: " Penn." QUEBEC: County not determined; Aylmer.

## species *incertae sedis*

Included in this category is *Badister submarinus* Mots., known to me through a single female cotype. As the classification used here is based mainly on the structure of the male genitalia, it was impossible to place this species. Because of the distinctive shape of the pronotum I suspect that *B. submarinus* should be placed in a species group of its own.

**Badister (Baudia) submarinus** Motschulsky

*Badister submarinus* Motschulsky, 1859: 158; [type [sic!] a female, in the Le Conte Coll., MCZ No. 8327, California]. Type locality: New Helvetia, California [= Sacramento].

*Badister ferrugineus submarinus* Le Conte, 1880: 165.

The diagnostic features of this species are presented in the key. The only additional aid for identification that can be given is to suggest that a specimen of the subgenus *Baudia*, which resembles *Badister* (*s. str.*) *f. ferrugineus* with respect to pronotal shape, is probably a member of this species.

*Description.*—Type [sic!], female, California. [MCZ No. 8327].

Length 4.30 mm., width 1.95 mm. Elytra uniformly rufous on dorsal surface (specimen probably teneral). Microsculpture: head, approximately isodiametric over entire dorsal surface, vertex not iridescent; pronotum, not noted; iridescence generally strong.

Head twice as wide as long, 0.26 in width the total length, 1.22 times wider than pronotum is long, 1.16 times wider than left elytron. Apices of mandibles truncate. Eyes large and prominent.

Pronotum cordate, 1.14 times wider than head, 1.39 times wider than long, 1.25 times wider at widest point than at apex, 1.25 times wider at widest point than at base, base as wide as apex, length of pronotum 0.21 of total length; widest before middle, anterior angles acute, sharp (in contrast to other species), sides incurving, diagonally posteriorly, the right side becoming straight about 1/2 way between basal and apical margins, the left side straightening very slightly in front of posterior angle; posterior angles sharp, not at all rounded (fig. 133).

Elytra 1.56 times wider than pronotum, 1.46 times longer than wide.

Retractile plates not examined.

TABLE 69

Subgenus *Baudia:* Variation in Total Length (mm.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *reflexus* ..... | 14 | 3.80–4.28 | 4.00 | 18 | 3.78–4.42 | 4.02 |
| *parviceps* ..... | 14 | 3.60–4.12 | 3.81 | 23 | 3.42–4.15 | 3.76 |
| *grandiceps* ..... | 15 | 4.08–5.38 | 4.65 | 18 | 4.20–5.55 | 4.92 |
| *ocularis* ..... | 11 | 4.80–5.40 | 5.02 | 16 | 4.82–5.48 | 5.20 |
| *submarinus* ..... | | | | 1 | 4.30 | |

TABLE 70

Subgenus *Baudia:* Variation in Maximum Width (mm.).

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *reflexus* ..... | 14 | 1.72–1.90 | 1.80 | 18 | 1.60–1.98 | 1.79 |
| *parviceps* ..... | 14 | 1.58–1.92 | 1.70 | 23 | 1.60–1.88 | 1.69 |
| *grandiceps* ..... | 15 | 1.75–2.25 | 1.97 | 18 | 1.87–2.40 | 2.17 |
| *ocularis* ..... | 11 | 2.00–2.30 | 2.17 | 16 | 2.05–2.42 | 2.25 |
| *submarinus* ..... | | | | 1 | 1.95 | |

TABLE 71

Subgenus *Baudia:* Variation in W head/total length.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Species | N | Range | Mean | N | Range | Mean |
| *reflexus* ..... | 14 | 0.22–0.24 | 0.23 | 18 | 0.22–0.25 | 0.24 |
| *parviceps* ..... | 14 | 0.20–0.22 | 0.21 | 23 | 0.20–0.23 | 0.22 |
| *grandiceps* ..... | 15 | 0.20–0.24 | 0.23 | 18 | 0.23–0.26 | 0.25 |
| *ocularis* ..... | 11 | 0.23–0.25 | 0.24 | 16 | 0.23–0.28 | 0.24 |
| *submarinus* ..... | | | | 1 | 0.26 | |

TABLE 72

Subgenus *Baudia:* Variation in L PN/total length.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *reflexus* ..... | 14 | 0.19–0.21 | 0.20 | 18 | 0.19–0.21 | 0.20 |
| *parviceps* ..... | 14 | 0.22–0.24 | 0.23 | 23 | 0.22–0.24 | 0.22 |
| *grandiceps* ..... | 15 | 0.21–0.23 | 0.22 | 18 | 0.20–0.21 | 0.21 |
| *ocularis* ..... | 11 | 0.19–0.22 | 0.20 | 16 | 0.19–0.21 | 0.20 |
| *submarinus* ..... | | | | 1 | 0.21 | |

TABLE 73

Subgenus *Baudia:* Variation in W head/L Pn.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *reflexus* ..... | 14 | 1.09–1.23 | 1.17 | 18 | 1.13–1.26 | 1.22 |
| *parviceps* ..... | 14 | 0.90–1.00 | 0.94 | 23 | 0.87–1.03 | 0.96 |
| *grandiceps* ..... | 15 | 1.00–1.19 | 1.07 | 18 | 1.04–1.33 | 1.20 |
| *ocularis* ..... | 11 | 1.09–1.22 | 1.17 | 16 | 1.11–1.30 | 1.23 |
| *submarinus* ..... | | | | 1 | 1.22 | |

TABLE 74

Subgenus *Baudia:* Variation in W head/W elytron.

| Species | Males N | Males Range | Males Mean | Females N | Females Range | Females Mean |
|---|---|---|---|---|---|---|
| *reflexus* ..... | 14 | 1.00–1.14 | 1.06 | 18 | 1.00–1.17 | 1.08 |
| *parviceps* ..... | 14 | 0.87–1.06 | 0.96 | 23 | 0.92–1.03 | 0.96 |
| *grandiceps* ..... | 15 | 1.02–1.19 | 1.08 | 18 | 1.03–1.25 | 1.12 |
| *ocularis* ..... | 11 | 1.04–1.17 | 1.09 | 16 | 1.06–1.18 | 1.12 |
| *submarinus* ..... | | | | 1 | 1.12 | |

TABLE 75

Subgenus *Baudia:* L shaft M.L/L left paramere.

| Species | N | Range | Mean |
|---|---|---|---|
| *reflexus* ..... | 14 | 1.40–1.54 | 1.51 |
| *parviceps* ..... | 14 | 1.52–1.87 | 1.64 |
| *grandiceps* ..... | 15 | 1.52–1.86 | 1.63 |
| *ocularis* ..... | 10 | 1.70–2.22 | 1.99 |

## Phylogeny of the Genus Badister

The following hypothesis concerning the possible course of morphological evolution in this genus, with special reference to the North American species, rests on certain ideas and assumptions. The premises presented here concern particular morphological features which are utilized in constructing the phylogeny of this genus.

*A*. Notching of the mandibles: it cannot be definitely shown whether the notching of the right or left mandible is the more primitive condition, but because the notch in the right mandible is in general associated with other characters believed to be primitive, it may be assumed that the opposite condition is derivative, and therefore that the ancestral stock of the genus had the right mandible notched.

*B*. The reversal in mandibular notching was accomplished at a single step, and did not require a long slow process of gradual change. This idea is proposed because no species known to me exhibits intermediate conditions, that is, either the right or the left mandible is notched, but not both, or neither one.

*C*. The presence of three sclerotized strips on the dorsal surface of the median lobe is more primitive than only two, and there has been a progressive shift basad of the origin of the sclerotized strips within group 2 of the Licinini. This involves the further assumption that *Diplocheila* and *Dicaelus*, which have four sclerotized strips originating more apically, represent a more or less ancestral condition, and that the more apical origin of the strips in *Licinus* and the more extensive dorsal sclerotization of the median lobe are primitive within group 2 of the Licinini. Thus the evolutionary trend may be increased membranization of the median lobe, a shifting basad of the point of origin of the sclerotized strips, and a reduction in the number of these strips.

*D*. Female retractile plates: the relatively longer and more slender digitus of the stylus, the acute median basal angle, and the moderately long to elongate and slender setae of the stylus is more primitive than the stylus with short digitus, obtusely rounded median basal angle, and short broad setae, as the latter condition is restricted to only one group of species, whereas the former is found in all three subgenera. Further, the former condition is

characteristic of the other licinine genera known to me.

*E*. Color: such a character is usually more subject to variation than are other structural features. As dark piceous or black is such a common color in most other licinine genera, we may assume that the ancestral population of *Badister* was concolorous and probably black.

*F*. Microsculpture and lustre: microsculpture, in general, tends to be isodiametric or slightly transverse on the dorsal surface of the head, pronotum and elytra in Carabidae in general, and consequently the surface of these sclerites lack an iridescent lustre. In *Badister,* the primitive condition for the microsculpture of the head and pronotum is probably isodiametric, without iridescent lustre. The elytra, however, have the lines of microsculpture very close together and transverse, and the surface has an iridescent lustre, in all but a very few species that are known to me. From this I surmise that the ancestral stock had transverse elytral microsculpture, and that the loss of this feature is a derived condition.

*G*. Armature of the internal sac: probably the primitive condition within the tribe is lack of any armature on the internal sac. Species whose genitalia most closely approach this condition are presumably primitive with respect to this feature. In the species of *Badister* known to me, the simplest condition is found in *B. sodalis,* a species in which the only armature of the internal sac consists of a weakly sclerotized plate on the dorsal rim of the opening of the ejaculatory duct. This same condition occurs in the *pulchellus* complex of *Badister* (*s. str.*). Addition of a ventral apical plate and/or preapical plates and spines may be regarded as a specialized or derivative condition.

*H*. Tarsi: the presence of a row of setae on each ventro-lateral margin of the claw-bearing tarsal segment may be regarded as primitive, as this is the condition in the majority of carabid species. The absence of the setae, then, may be regarded as a derivative condition.

The above discussion yields a set of features which may be attributed to the ancestral stock of the genus *Badister.* These are: right mandible with a deep notch in dorsal surface; microsculpture of head and pronotum more or less isodiametric, of elytra strongly transverse

and surface with an iridescent lustre; color uniformly dark, probably black; median lobe of male genitalia with three sclerotized strips, the right arising from apex of basal bulb, the left arising in apical 2/3 of shaft, but above plane of origin of right strip, the median very slender, not attached, but sloping basally, toward left strip; internal sac with a single weakly sclerotized dorsal sclerotized plate, and no preapical spines or plates; stylus of female retractile plates with slender setae, digitus slender, and median basal angle acute.

The rest of this discussion may be followed with reference to diagram 3. Numbers in parentheses refer to numbers on the diagram.

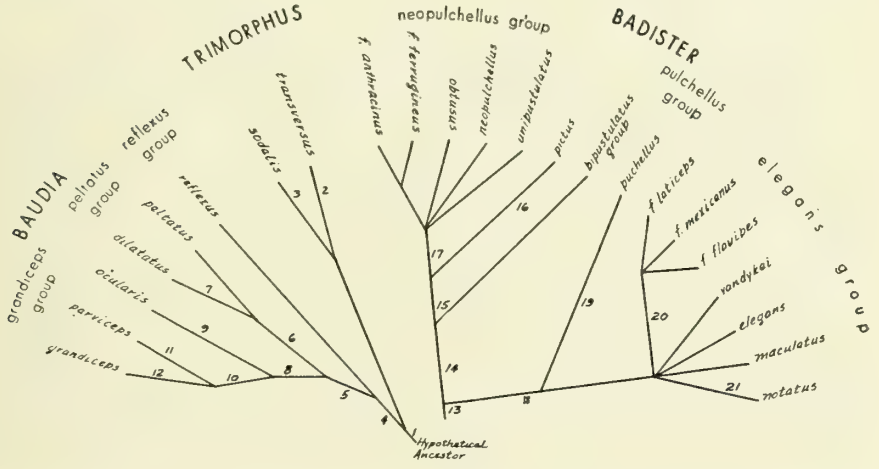


Diagram 3.—A diagrammatic representation of the structural relationships and possible phylogeny of the species of *Badister*.

Following first the left portion of the diagram, these changes may have occurred to produce the species included in the subgenus *Trimorphus:* microsculpture of the pronotum became strongly transverse, and the surface became iridescent; ventro-lateral setae of the claw bearing tarsal segment were lost (1). The species *transversus* may have evolved from the basal stock of *Trimorphus* by the development of 3-5 apical spines on the internal sac (2), and *sodalis,* by the development of transverse microsculpture on the vertex of the head, and iridescent lustre correlated with it, and decrease in pigment of the humeral areas of the elytra (3).

The *Trimorphus* stock may have given rise to the ancestral stock of *Baudia* (4) by the production of a population having the mandibles reversed, i.e. left mandible notched, right normal, the basal migration of the left sclerotized strip of the median lobe, and development of a ventral apical plate. The features of the genitalia are essentially those of *B.* (*Baudia*) *reflexus* LeC. By increased sclerotization of the dorsal apical plate, complete loss of the median sclerotized strip, the stage may have been set for the next development (5). Two phyletic branches may have arisen from point 5: one, including *dilatatus* and *peltatus*, the other the species *grandiceps*, *parviceps*, and *ocularis*. For the production of the *peltatus* branch (6), it would be necessary to imagine only the development of a notch on the right margin of the ventral apical plate, and the development of a basal portion to the dorsal apical plate, which develops at an angle to the main axis of the latter. *Dilatatus* could have arisen from a *peltatus*-like ancestral stock by the addition of two preapical plates to the internal sac, and development of iridescence on the vertex of the head (7). The *grandiceps* branch probably possessed a tendency to develop spines or projections from the apical plates of the internal sac, and to develop preapical plates (8). This stock may have produced two lines, one of which produced the living species *ocularis*, having a long projection arising from the apex of the ventral sclerotized plate and a single preapical plate (9). The other line probably developed a spine on the dorsal surface of the dorsal apical plate, and a larger preapical plate than in *B. ocularis* (10), and gave rise to the more primitive product of this line, *parviceps* (11), and *grandiceps* (12), the more derivative species.

Returning to the base of the diagram we find that the putative ancestral characters of the genus are essentially those of the typical subgenus, as defined here. Body color and structure of the male genitalia are the only features which do not fit *Badister* (*s. str.*) as a whole. Because bicolored or spotted elytra are the rule within the subgenus, and concolorous elytra the exception, I postulate that the former is primitive, and that concolorous in the living species is derivative. With respect to pronotal color, orange-testaceous is believed to be primitive in the *Badister* (*s. str.*) line as this color (as well as the spotted elytra) occurs in both species complexes and is the color of the pronotum of *B. pulchellus*, a species which, on other features, is believed to be the most

primitive in the *pulchellus* complex. To proceed, the derivation of the hypothetical ancestral stock of the subgenus *Badister* from the ancestral stock of the genus as a whole involves only a depigmentation of the pronotum and of a portion of the elytra (13). Each complex of the typical subgenus exhibits certain features which are believed to be primitive, others which seem to be derivative in nature.

The *bipustulatus* complex may be derived from the hypothetical ancestral stock by assuming the development of a ventral apical plate on the internal sac of the median lobe in the male, and the increased sclerotization of the dorsal apical plate. The stylus of the female retractile plates may have been produced by broadening and shortening the digitus, widening the median basal angle, and shortening and broadening the setae on the outer margin (14). Two main lines of descent may have been produced from this development. First, the *bipustulatus* branch including at least the type species of the genus, *kineli* Makolski, 1952, and *lacertosus* Sturm. The males of this unit do not have preapical plates or spines on the internal sac of the genitalia, and the apex of the median lobe is relatively simple, with the development of a small, simple, ventral hook. The second line of descent includes *pictus, unipustulatus, neopulchellus, ferrugineus,* and *obtusus.* The males of this series of species have the apical portion of the median lobe inclined ventrally and usually terminating in a broad protuberance. In addition, a variable number of preapical plates are to be seen on the internal sac. The dorsal apical plate is produced into a broad, short prominence in *unipustulatus, neopulchellus, obtusus,* and *ferrugineus* (16). In *pictus,* the apical projection is a slender, curved spicule that is probably derived from the *neopulchellus* type of apical plate (17). I am not prepared to discuss the relationships of the Palaearctic species to one another, or to the American species, except to suggest that on the basis of similarity of the shape of the male genitalia, *unipustulatus* is closely related to, but specifically distinct from the North American *neopulchellus, ferrugineus* and *obtusus.* These species are probably closely related and have probably been derived from a common stock, with *neopulchellus* most like the ancestral population and *obtusus* and *ferrugineus* further removed: *obtusus* resembles *neopulchellus* with respect to pronotal shape. In contrast, the elytra of *obtusus* are " unspotted ", that is, they lack the black areas characteristic of *neopulchellus.* The apex

of the median lobe of *obtusus* may be interpreted either as a reduction product of the *neopulchellus* type, or a more primitive condition leading up to the latter type. I think that the former interpretation is the correct one. Of the two races of *ferrugineus*, the typical subspecies is more derivative in body proportions, but more primitive, i.e. more like *neopulchellus*, in shape of the apical portion of its median lobe.

The remaining complex of *Badister* (*s. str.*) may have been derived from the ancestral stock by the following changes in the characters of the former: the disappearance of the median sclerotized strip of the median lobe, and the migration of the origin of the left strip basad to the plane at which the right strip arises (18). From a stock with genitalic characters such as these, *Badister pulchellus* could have been derived by the development of two small spines dorsally on the internal sac (19), and the remaining species of the complex by the development of two strong spines, one dorsal and the other lateral in position, and the darkening of the pronotum. From the latter stem, three stocks may have originated, all of which are quite similar with respect to structural features. One of these, characterized by spotted elytra and flat elytral intervals, may have produced the species *elegans*, *maculatus*, and *vandykei*. A second stock with concolorous elytra and flat elytral intervals may have given rise to *flavipes*, and the third, with faintly bicolored elytra, lacking microsculpture on the pronotum, with the lines of microsculpture on the head faintly indicated, and elytral intervals convex may have given rise to *B. notatus* (21). Probably relatively recently a mutation occurred in the *notatus* population which caused atrophy of the metathoracic wings.

*Convergence.*—According to this system, the following characters may have been derived at least twice, independently: 1. concolorous, or at least not sharply bicolored, elytra—possibly four times; 2. ventral sclerotized apical plate on internal sac—twice; 3. loss of median sclerotized strip on median lobe and shift of origin of left sclerotized strip basad—twice; 4. development of preapical plates on internal sac—twice; 5. development of preapical spines on internal sac—three times.

## Zoogeography of the Genus *Badister*

With the exception of South America, Australia, and Antarctica, the genus *Badister* (*s. lat.*) occurs on all of the major land-masses of the world, going as far south in Africa as the Cape Region, in Europe as far north as the vicinity of Leningrad in the Old World. However, in North America representatives of the genus have not yet been taken north of 58 degrees latitude, but at least two species, *B. neopulchellus* and *obtusus* probably range northward to the tree line, which in the western portion of the continent extends north of the Arctic Circle.

The fact that this genus does not occur on the three southern land masses mentioned above suggests *Badister* may have originated later than Eocene time, for during that epoch South America was joined to North America, and Australia may have been connected with southeastern Asia via the Indo-Australian archipelago. Presumably, if this genus had been in existence then it would have invaded these areas.

The subgenus *Badister* is not known from Africa, or the West Indies, but is otherwise distributed throughout the range mentioned above. *Trimorphus*, as defined here, is known so far only from the Holarctic, while *Baudia* is widely distributed on the Eurasiatic continent and occurs in Africa, the Indo-Australian Archipelago, Philippine Islands, North America, and the West Indies.

The genus may have arisen in the Old World in either the Palaearctic or Oriental Region, because most of the Licinini are restricted to the Old World and presumably they originated there. In addition, all of the groups which I believe to be closely related to *Badister* are restricted in their distribution to the Old World: *Eurygnathus* on Madeira Island, *Licinus* in Eurasia, *Omestes* and one other *Badister*-like genus from the Philippines. (I have seen unidentified and possibly undescribed specimens that fall in the latter category in the collection of the Museum of Comparative Zoology.) The assumption implicit here is that center of origin of a group is correlated with the area of greatest abundance of its near relatives. The remaining portion of the discussion of zoogeography will be concerned largely with the development of the distributional patterns of the living North American species. An outline of the distribution pattern of *Badister* in North America follows.

The species of the *pulchellus* complex of the typical subgenus are primarily residents of the temperate to subtropical portions of eastern

North America and Mexico. This complex is not known from west of the Rocky Mountains in United States, but one species, *Badister vandykei*, occurs in Baja, California. The North American species of the *neopulchellus* group are primarily northern and western in North America with *ferrugineus* known only from the West Coast, eastward into western Nevada, *obtusus* widely distributed in the north but not known to occur west of the Rockies or south of Colorado (in the mountains?), and *neopulchellus* ranging from Texas in the south, to relatively high latitudes in the Northern Coniferous Forest, and ranging in that forest from the Atlantic to the Pacific Coast. The single American representative of *Trimorphus*, *B. transversus* Casey, is known only from temperate eastern North America; it is not known to occur south of Washington D. C., west of Illinois, or in the Northern Coniferous Forest. Three of the species of *Baudia* are restricted in their distributions to eastern North America. One of these, however, *reflexus*, does occur in the West Indies. The fourth species, *grandiceps*, is transcontinental in the Northern Coniferous Forest, and ranges southward in eastern North America to at least Washington, D. C. It is apparent, then, that the great majority of the species of *Badister* are restricted to the eastern portion of North America and do not enter the Boreal or Northern Coniferous Forest. These species constitute the main faunal element of the genus. A second faunal element is represented by those species which do occur in the boreal forest, or in extreme western North America.

The history of the development of this distribution pattern may have been along these lines. The ancestral stocks of the *pulchellus* complex of *Badister*, of *Trimorphus transversus*, and of the subgenus *Baudia* (probably two stocks) invaded North America in pre-Pleistocene time from the Palaearctic via a Bering land bridge. As the derivatives of these stocks today, for the most part, are living under relatively warm conditions, it is not unlikely that the ancestral populations themselves also did so in the past. This would seem to pose the problem of dispersing the temperate groups of the genus into cooler boreal conditions. But if these stocks migrated fairly early in the Tertiary, and I think that the large morphological gaps between the temperate North American species and their Old World counterparts or absence of close relations in the Old World (there are not any Palaearctic counterparts

of the *pulchellus* complex) indicate a long period of isolation, then the ancestral stocks could have crossed the Bering land bridge, or dispersed across the narrow open water gap under temperate climatic conditions. (See Chaney, 1947: 144-146).

A fairly early differentiation of the *pulchellus* complex stock probably produced the species *pulchellus* and the ancestral stock of the *elegans* group. The ancestral *elegans* group stock probably dispersed widely in the eastern Arcto-Tertiary Forest, probably extending northward to the edge of the boreal forest, southward through favorable areas in Mexico to the edge of the tropical forests, and westward into drier situations. This widespread population or series of populations may have differentiated initially into three units: a southern subtropical-tropical population (ancestral *flavipes*), a central population (ancestral *elegans-maculatus-vandykei*), and an eastern population (ancestral *notatus*). In the course of time, *flavipes* may have migrated northward and produced the three living subspecies, the Mexican *mexicanus*, the eastern Gulf Coast-Floridian *flavipes*, and the widespread eastern and east-central *laticeps*. If the ancestral *elegans-maculatus-vandykei* population did arise in the area postulated, i.e. somewhere in or near the present range of *elegans*, then it probably dispersed eastward and westward and differentiated into a series of three populations: the eastern one giving rise to *maculatus*, the central population producing *elegans*, and the western unit giving rise to *vandykei*. The presumed areas of differentiation of the three basic stocks of the living species is based upon the areas of occurrence of the morphologically primitive member of each group: *f. mexicanus* in southern Mexico, *elegans* in the Mississippi Basin area, and *notatus* occupying the eastern forests and possibly later dispersing westward into the northern portion of the range of *elegans*. I cannot suggest a geographical arrangement of populations for the differentiation of the ancestral stock of the *pulchellus* complex into *pulchellus* and the ancestral stock of the *elegans* group, as *pulchellus* overlaps the ranges of half of the species of the latter group. Possibly the differentiation of the *elegans* stock into the species and subspecies recognized, occurred fairly recently in geological history, possibly in the early Pleistocene. I suggest this because all of the species are fairly closely related to one another, and so probably did not diverge too long ago.

No problem is involved in explaining the distribution pattern of the subgenus *Trimorphus* in North America as it is represented by only one species which is restricted to the east. The same may be said for *Baudia reflexus*.

A discussion of the differentiation of the *grandiceps* group of *Baudia* is complicated by the fact that the ranges of distribution of all three species overlap one another broadly, but they do not overlap totally, and this fact coupled with the assistance of the evidence derived from comparative morphology may enable us to arrive at a plausible explanation of the origin of the distribution pattern. The rather striking difference in the male genitalia between *Baudia ocularis* and the other two species suggests that the three species represent two stocks, each of which may be comparatively old. The stock which gave rise to *ocularis* may have been primarily adapted to a warmer climate than that to which the *grandiceps-parviceps* stock was adapted. The fact that *ocularis* ranges farther south than the other two species is suggestive of this. The *grandiceps-parviceps* stock may have been adapted to cooler conditions, and thus ranged through both the boreal and more northern portion of the temperate Arcto-Tertiary flora. With the development of the Pleistocene glaciation, the original stock may have been divided into two: one south and east of the glacial front (*parviceps*), the other either in a glacial refugium, possibly the eastern coast of Canada, or possibly in the state of Washington south of the glacial front (*grandiceps*). The resulting isolation allowed the two populations thus produced to diverge sufficiently morphologically, and presumably genetically, to be regarded as a distinct species. With the retreat of the glaciers, the ranges of the two species expanded to their present day limits. If *grandiceps* originated in the west, then it moved eastward along the marginal areas of the boreal forest to the east coast and then southward. If the centre of origin of this species was in the east, then it dispersed westward.

The remaining North American faunal element of *Badister* is the boreal-western *neopulchellus* group. The close structural similarity between these species and the Palaearctic representatives of the group suggests that the former have been inhabitants of North America for a relatively short time. Possibly the *neopulchellus* group and the *bipustulatus* group arose from a common ancestor in late Tertiary time.

Possibly the former stock in middle or late Pleistocene time invaded North America via the boreal forest and possessed sufficient variability to move southward into the eastern deciduous forest. This stock then diverged from its old world counterpart, the former producing *neopulchellus, obtusus* and *ferrugineus* and the latter giving rise to *unipustulatus.* The return of a continental ice sheet may have caused the division of the North American stock into three components: a *ferrugineus-anthracinus* population to the west of the Cascades; a *neopulchellus* population in eastern North America; and an *obtusus* population in a glacial refugium, possibly on the eastern coast of Canada. These populations then differentiated into three species. With the retreat of the glaciers all dispersed northward or up mountain sides and eventually attained their present distributions. In addition, the *ferrugineus* stock differentiated into two races: a northern or highland subspecies and a southern lowland subspecies.

## Acknowledgements

I am indebted to the following entomologists for their cooperation in this study, particularly for the loan of material: Dr. E. H. Strickland, formerly of the University of Alberta; Mr. J. Balfour-Browne, British Museum (Natural History); Dr. J. Manson Valentine, Highlands, North Carolina; Dr. R. L. Chermock, University of Alabama; Dr. M. A. Cazier, American Museum of Natural History; Mr. W. J. Brown, Department of Agriculture, Ottawa, Ontario; Mr. H. B. Leech, California Academy of Sciences; Dr. H. Dietrich, Cornell University; Dr. M. W. Sanderson, Illinois Natural History Survey, Urbana, Illinois; Dr. H. E. Jacques, Iowa Wesleyan College; Dr. R. H. Beamer, University of Kansas; Dr. T. H. Hubbell, University of Michigan, Museum of Zoology; Dr. W. C. Stehr, University of Ohio; Dr. J. Wilcox, New York State Museum; Mr. R. T. Everly, Purdue University; Mr. J. A. G. Rehn, Academy of Natural Sciences of Philadelphia; Dr. R. H. Arnett, and Dr. W. Anderson, United States National Museum; Dr. C. E. Mickel, University of Minnesota; Dr. A. B. Champlain, Bureau of Plant Industry, Harrisburg, Pennsylvania; Dr. S. W. Frost, Pennsylvania State College.

Dr. P. J. Darlington, Jr., and Mr. J. Balfour-Browne loaned me the material on which the revision of the Old World species of *Diplo-*

*cheila* is based. Dr. Carl H. Lindroth compared specimens of North American Licinini with the Dejean types (Oberthür Collection).

The original manuscript, submitted as a thesis at Cornell University for the degree of Ph.D., was prepared with the cooperation and advice of Drs. V. S. L-L. Pate, W. T. M. Forbes, J. G. Franclemont, and H. E. Evans. The preparation of this condensed version was made with the advice of Dr. B. Hocking, University of Alberta.

My wife, Dr. Kathleen Ball, contributed many useful criticisms and suggestions, and aided in the preparation of the plates.

Miss Joan Shore, stenographer-technician of this Department, typed the manuscript.

Expense of publication of this paper has been defrayed in part by a grant from the General Research Fund of the University of Alberta, and I gratefully acknowledge this assistance.

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## Explanation of Figures

### Plate I

Figs. 1a-e.—Mandibles of *Diplocheila polita.*
- a. left mandible, dorsal aspect.
- b. same, ventral aspect.
- c. same, lateral aspect.
- d. right mandible, dorsal aspect.
- e. right mandible, ventral aspect.

tm—terebral margin; tt—terebral tooth; rt—retinacular tooth; bm—basal margin; rr—retinacular ridge; vg—ventral groove.

Figs. 2a-e.—Same of *Diplocheila daldorfi.*
- a. left mandible, dorsal aspect.
- b. same, ventral aspect.
- c. same, lateral aspect.
- d. right mandible, dorsal aspect.
- e. right mandible, ventral aspect.

Fig. 3.—Left mandbile of *Diplocheila colossa,* dorsal aspect.

Figs. 4a-e.—Mandibles of *Diplocheila latifrons.*
- a. left mandible, dorsal aspect.
- b. same, ventral aspect.
- c. same, lateral aspect.
- d. right mandible, dorsal aspect.
- e. right mandible, ventral aspect.

Figs. 5a-e.—Same of *Diplocheila zeelandica.*
- a. left mandible, dorsal aspect.
- b. same, ventral aspect.
- c. same, lateral aspect.
- d. right mandible, dorsal aspect.
- e. same, ventral aspect.

Figs. 6a-e.—Same of *Diplocheila striatopunctata.*
- a. left mandible, dorsal aspect.
- b. same, ventral aspect.
- c. same, lateral aspect.
- d. right mandible, dorsal aspect.
- e. same, ventral aspect.

Fig. 7.—Left mandible of *Diplocheila cordicollis,* dorso-medial aspect.

Fig. 8.—Left mandible of *Diplocheila aegyptiaca,* dorso-medial aspect.

Fig. 9.—Left mandible of *Diplocheila major,* lateral aspect.

## Plate II

Fig. 10.—Basal portion of left elytron of *Diplocheila polita.*
Fig. 11.—Same of *Diplocheila colossa.*
Fig. 12.—Same of *Diplocheila daldorfi.*
Figs. 13a-b.—Clypeus and labrum of *Diplocheila daldorfi.*
a. clypeus.
b. labrum.
Figs. 14a-b.—Same of *Diplocheila colossa.*
Figs. 15a-b.—Same of *Diplocheila exotica.*
Figs. 16a-b.—Same of *Diplocheila polita.*
Figs. 17a-b.—Same of *Diplocheila elongata.*
Figs. 18a-b.—Same of *Diplocheila indus.*
Fig. 19.—Labrum of *Diplocheila laevigatoides.*
Figs. 20a-b.—Clypeus and labrum of *Diplocheila l. latifrons.*
Figs. 21a-b.—Same of *Diplocheila pinodes.*
Figs. 22a-b.—Same of *Diplocheila aegyptiaca.*
Figs. 23a-b.—Same of *Diplocheila striatopunctata.*
Fig. 24.—Pronotum of *Diplocheila daldorfi.*
Fig. 25.—Same of *Diplocheila colossa.*
Fig. 26.—Same of *Diplocheila polita.*
Fig. 27.—Same of *Diplocheila quadricollis.*
Fig. 28.—Same of *Diplocheila indus.*
Figs. 29 and 30.—Same of *Diplocheila laevigata.*
Fig. 31.—Same of *Diplocheila laevigatoides.*
Fig. 32.—Same of *Diplocheila l. latifrons.*
Fig. 33.—Same of *Diplocheila l. darlingtoni.*

## Plate III

Fig. 34.—Pronotum of *Diplocheila zeelandica.*
Fig. 35.—Same of *Diplocheila laevis.*
Fig. 36.—Same of *Diplocheila cordicollis.*
Fig. 37.—Same of *Diplocheila aegyptiaca.*
Fig. 38.—Same of *Diplocheila striatopunctata.*
Fig. 39.—Same of *Diplocheila oregona.*
Fig. 40.—Same of *Diplocheila modesta.*
Fig. 41.—Same of *Diplocheila a. assimilis.*
Fig. 42.—Same of *Diplocheila a. planulata.*
Fig. 43.—Same of *Diplocheila nupera.*
Fig. 44.—Same of *Diplocheila m. major.*
Fig. 45.—Same of *Diplocheila m. melissisa.*
Fig. 46.—Same of *Diplocheila obtusa.*
Fig. 47.—Same of *Diplocheila undulata.*
Fig. 48.—Eighth sternite of *Diplocheila polita,* female.

Fig. 49.—Right half of eighth sternite of *Diplocheila daldorfi,* female.
Fig. 50.—Same of *Diplocheila latifrons.*
Fig. 51.—Same of *Diplocheila zeelandica.*
Fig. 52.—Same of *Diplocheila aegyptiaca.*
Fig. 53.—Same of *Diplocheila striatopunctata.*

## Plate IV

Fig. 54.—Tenth tergite and retractile plates of *Diplocheila polita,* dorsal aspect.
a. tenth tergite.
b. valvifer.
c. coxite.
d. stylus.
Fig. 55.—Left retractile stylus, ventral aspect, of *Diplocheila daldorfi.*
Fig. 56.—Same of *Diplocheila colossa.*
Fig. 57a-c.—Same of *Diplocheila polita.*
Fig. 58.—Same of *Diplocheila quadricollis.*
Fig. 59.—Same of *Diplocheila distinguenda.*
Fig. 60.—Same of *Diplocheila elongata.*
Fig. 61.—Left retractile stylus, dorsal aspect, of *Diplocheila indus.*
Fig. 62.—Left retractile stylus, ventral aspect, of *Diplocheila laevigata.*
Fig. 63.—Same of *Diplocheila laevigatoides.*
Fig. 64.—Same of *Diplocheila latifrons.*
Fig. 65.—Same of *Diplocheila zeelandica.*
Fig. 66.—Same of *Diplocheila pinodes.*
Fig. 67.—Same of *Diplocheila laevis.*
Fig. 68.—Same of *Diplocheila aegyptiaca.*
Fig. 69.—Same of *Diplocheila striatopunctata.*
Figs. 70a-b.—Male genitalia of *Diplocheila daldorfi.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Figs. 71a-b.—Same of *Diplocheila colossa.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.

## Plate V

Figs. 72a-c.—Same of *Diplocheila polita.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
c. apical plate of internal sac, dorsal aspect.
Figs. 73a-b.—Same of *Diplocheila elongata.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Figs. 74a-b.—Same of *Diplocheila indus.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.

Figs. 75a-b.—Male genitalia of *Diplocheila laevigata.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Figs. 76a-b.—Same of *Diplocheila laevigatoides.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Figs. 77a-b.—Same of *Diplocheila latifrons.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.

## Plate VI

Figs. 78a-c.—Male genitalia of *Diplocheila zeelandica.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
c. apical portion of shaft of median lobe, dorsal aspect.
Figs. 79a-d.—Same of *Diplocheila laevis.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
c. left paramere, ventral aspect.
d. right paramere, ventral aspect.
Figs. 80a-c.—Same of *Diplocheila cordicollis.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
c. basal portion of median lobe, dorsal aspect.
Figs. 81a-c.—Same of *Diplocheila aegyptiaca.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
c. apical portion of shaft of median lobe, dorsal aspect.
Figs. 82a-d.—Same of *Diplocheila striatopunctata.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
c. apical portion of shaft of median lobe, dorsal aspect.
d. basal portion of median lobe, dorsal aspect.

## Plate VII

Figs. 83a-d.—Mandibles of *Dicaelus elongatus.*
a. left mandible, dorsal aspect.
b. same, ventral aspect.
c. right mandible, dorsal aspect.
d. same, ventral aspect.
Figs. 84a-d.—Same of *Dicaelus teter.*
a. left mandible, dorsal aspect.
b. same, ventral aspect.

c. right mandible, dorsal aspect.
d. same, ventral aspect.

Figs. 85a-b.—Mandible of *Dicaelus purpuratus.*
a. left mandible, dorsal aspect.
b. same, ventral aspect.
c. right mandible, dorsal aspect.
d. same, ventral aspect.

Figs. 86a-d.—Same of *Dicaelus furvus.*
a. left mandible, dorsal aspect.
b. same, ventral aspect.
c. right mandible, dorsal aspect.
d. same, ventral aspect.

## Plate VIII

Figs. 87a-b.—Mandible of *Dicaelus dilatatus.*
a. left mandible, dorsal aspect.
b. same, ventral aspect.

Figs. 88a-b.—Same of *Dicaelus costatus.*
a. left mandible, dorsal aspect.
b. right mandible, dorsal aspect.

Figs. 89a-d.—Same of *Dicaelus l. laevipennis.*
a. left mandible, dorsal aspect.
b. same, ventral aspect.
c. right mandible, dorsal aspect.
d. same, ventral aspect.

Figs. 90a-b.—Same of *Dicaelus l. dicaeloides.*
a. left mandible, dorsal aspect.
b. same, ventral aspect.

Fig. 91.—Pronotum of *Dicaelus elongatus.*
Fig. 92.—Same of *Dicaelus politus.*
Fig. 93.—Same of *Dicaelus teter.*
Fig. 94.—Same of *Dicaelus ambiguus.*
Fig. 95.—Same of *Dicaelus furvus.*
Fig. 96a.—Same of *Dicaelus d. dilatatus,* Cornish, N. H.
Fig. 96b.—Same of *Dicaelus dilatatus,* intergrade (*planicollis* LeC), Atlanta, Ga.

## Plate IX

Fig. 96c.—Pronotum of *Dicaelus dilatatus,* intergrade (*carolinensis* Casey), Southern Pines, N. C.
Fig. 97.—Same of *Dicaelus d. sinuatus,* Beck's Run, All'y, Pa.
Fig. 98.—Same of *Dicaelus p. purpuratus,* L. Waccamaw, N. C.
Fig. 99.—Same of *Dicaelus p. darlingtoni,* Ft. Myers, Fla.
Fig. 100.—Same of *Dicaelus crenatus.*

Fig. 101.—Pronotum of *Dicaelus costatus.*
Fig. 102.—Same of *Dicaelus l. laevipennis.*
Fig. 103.—Same of *Dicaelus chermocki,* new species, Type.
Fig. 104.—Same of *Dicaelus suffusus.*
Fig. 105.—Eighth sternite of *Dicaelus purpuratus,* female.

## Plate X

Fig. 106.—Tenth tergite and retractile plates of *Dicaelus purpuratus.*
Figs. 107a-b.—Male genitalia of *Dicaelus elongatus.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, dorsal aspect.
Figs. 108a-b.—Same of *Dicaelus politus.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Fig. 109.—Internal sac of *Dicaelus ambiguus.*
Figs. 110a-b.—Male genitalia of *Dicaelus furvus.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Fig. 111.—Internal sac of *Dicaelus dilatatus.*
Figs. 112a-d.—Male genitalia of *Dicaelus p. purpuratus.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
c. left paramere, ventral aspect.
d. right paramere, ventral aspect.
Fig. 113.—Internal sac of *Dicaelus p. darlingtoni.*

## Plate XI

Figs. 114a-b.—Male genitalia of *Dicaelus crenatus.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Figs. 115a-b.—Same of *Dicaelus a. alternans.*
a. apical portion of shaft of median lobe, ventral aspect.
b. internal sac.
Figs. 116a-b.—Same of *Dicaelus costatus.*
a. median lobe, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.
Figs. 117a-b.—Same of *Dicaelus l. laevipennis.*
a. median lobe with internal sac everted, left lateral aspect.
b. apical portion of shaft of median lobe, ventral aspect.

## Plate XII

Fig. 118.—Pronotum of *Badister neopulchellus.*
Fig. 119a.—Same of *Badister f. ferrugineus,* L. Gatos, Cal.
Fig. 119b.—Same of *Badister f. anthracinus,* Type.

Fig. 120.—Pronotum of *Badister obtusus.*
Fig. 121.—Same of *Badister pulchellus.*
Fig. 122.—Same of *Badister elegans.*
Fig. 123.—Same of *Badister maculatus.*
Fig. 124.—Same of *Badister vandykei,* Type.
Fig. 125.—Same of *Badister f. flavipes,* Oneco, Fla.
Fig. 126.—Same of *Badister f. laticeps,* Sandusky Co., Ohio.
Fig. 127.—Same of *Badister notatus.*
Fig. 128.—Same of *Badister transversus.*
Fig. 129.—Same of *Badister reflexus.*
Fig. 130.—Same of *Badister ocularis.*
Fig. 131.—Same of *Badister grandiceps.*
Fig. 132.—Same of *Badister parviceps.*
Fig. 133.—Same of *Badister submarinus.*
Figs. 134a-h.—Male genitalia of *Badister neopulchellus.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. median lobe, dorsal aspect.
d. left paramere, ventral aspect.
e. right paramere, ventral aspect.
f. median lobe with internal sac everted.
g. ventral apical plate, ventral aspect.
h. dorsal apical plate, ventral aspect.

## Plate XIII

Figs. 135a-b.—Male genitalia of *Badister f. ferrugineus,* Palo Alto, Santa Clara Co., Calif.
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
Figs. 136a-b.—Same, Brentwood, Calif.
a. apex of shaft of median lobe, left lateral aspect.
b. shaft, ventral aspect.
Figs. 137a-b.—Same, S. Fork, Kings River, Fresno Co., Calif.
Figs. 138a-b.—Same, *Badister ferrugineus* × *anthracinus.*
Figs. 139a-b.—Same, Alemeda Co., Calif.
Figs. 140a-b.—Same, *Badister f. anthracinus,* Nevada.
Figs. 141a-b.—Same, Vancouver Island, British Columbia.
Figs. 142a-b.—Same, Oregon.
Figs. 143a-b.—Same, Oregon.
Figs. 144a-b.—Same, Oregon.
Figs. 145a-b.—Same of *Badister obtusus.*
a. median lobe, left lateral aspect.
b. shaft, ventral aspect.
Figs. 146a-d.—Male genitalia of *Badister pulchellus.*
a. median lobe, left lateral aspect.

b. shaft of median lobe, ventral aspect.
c. median lobe, dorsal aspect.
d. apical plate.

Figs. 147a-d.—Same of *Badister elegans.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. median lobe, dorsal aspect.
d. spines of internal sac.

Figs. 148a-c.—Same of *Badister maculatus.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. median lobe, dorsal aspect.

## Plate XIV

Figs. 149a-c.—Male genitalia of *Badister vandykei,* Type.
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. median lobe, dorsal aspect.

Figs. 150a-c.—Same of *Badister flavipes.*
a. median lobe, left lateral aspect.
b. shaft of median lobe in ventral aspect.
c. median lobe, dorsal aspect.

Figs. 151a-c.—Same of *Badister notatus.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. median lobe, ventral aspect.

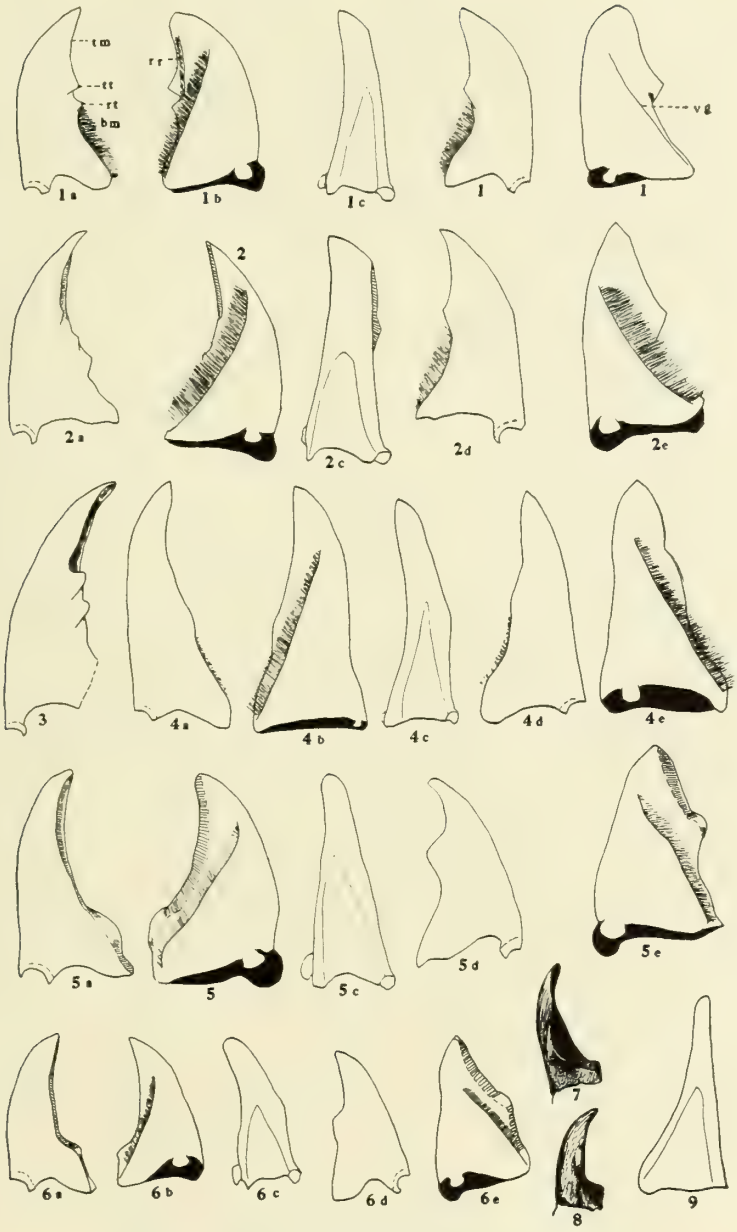
Figs. 152a-b.—Same of *Badister transversus.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.

## Plate XV

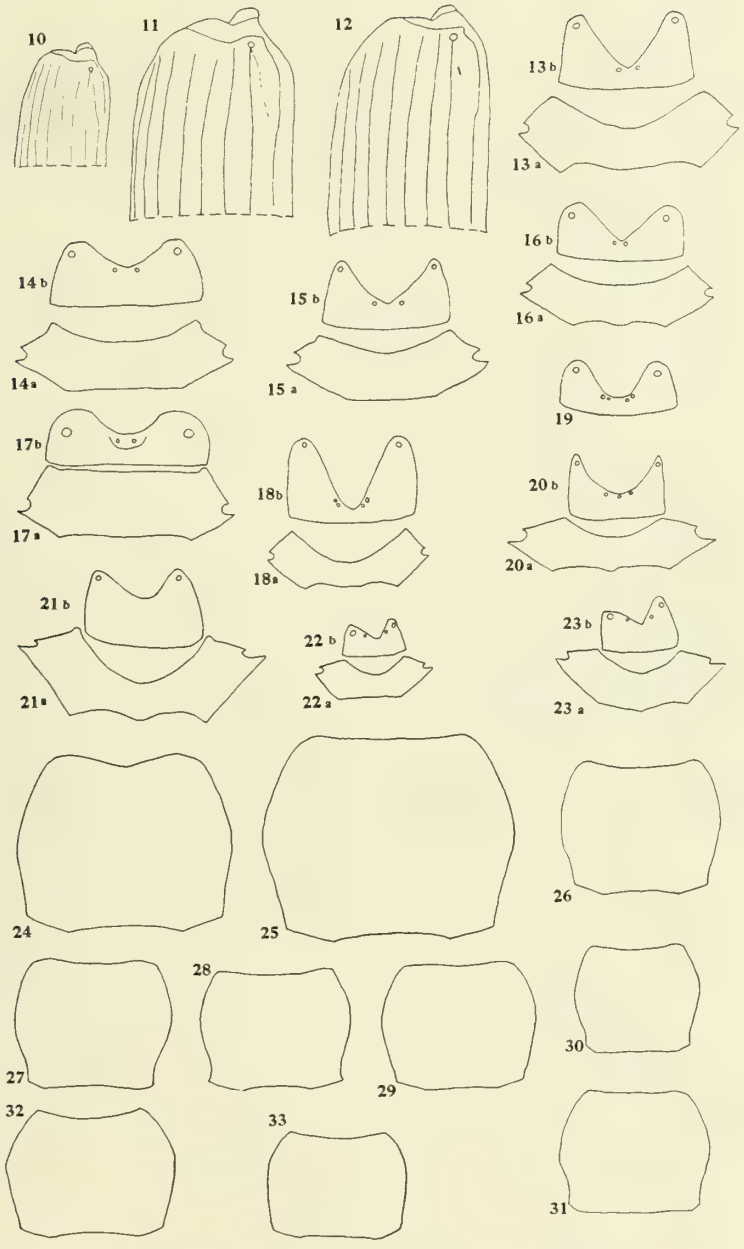
Figs. 153a-e.—Male genitalia of *Badister reflexus.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. apical plate of internal sac.
d. left paramere.
e. right paramere.

Figs. 154a-e.—Same of *Badister ocularis.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. ventral apical plate.
d. dorsal apical plate.
e. preapical plate.

Figs. 155a-c.—Male genitalia of *Badister grandiceps.*
a. median lobe, left lateral aspect, with internal sac averted.
b. shaft of median lobe, ventral aspect.
c. apical plates of internal sac, dorsal aspect.
Figs. 156a-e.—Same of *Badister parviceps.*
a. median lobe, left lateral aspect.
b. shaft of median lobe, ventral aspect.
c. dorsal apical plate, dorsal aspect.
d. ventral apical plate, ventral aspect.
e. preapical plate.
Fig. 157.—Left half of eighth sternite of *Badister neopulchellus,* female.
Fig. 158.—Tenth tergite of *Badister neopulchellus,* female.
Fig. 159.—Left retractile stylus of *Badister neopulchellus.*
Fig. 160.—Left half of eighth sternite of *Badister pulchellus,* female.
Fig. 161.—Left retractile stylus of *Badister pulchellus.*
Fig. 162.—Left half of eighth sternite of *Badister transversus,* female.
Fig. 163.—Left retractile stylus of *Badister transversus.*
Fig. 164.—Left half of eighth sternite of *Badister reflexus,* female.
Fig. 165.—Left retractile stylus of *Badister reflexus,* female.




BALL—NORTH AMERICAN LICININI

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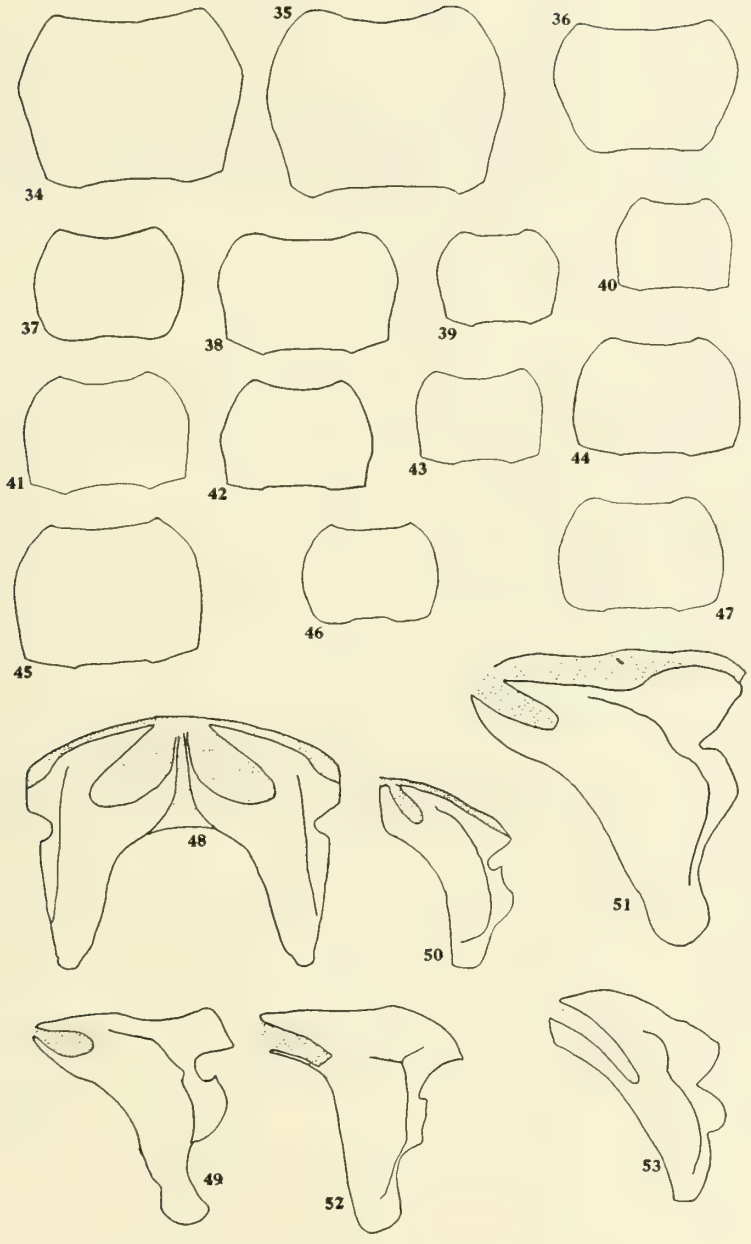


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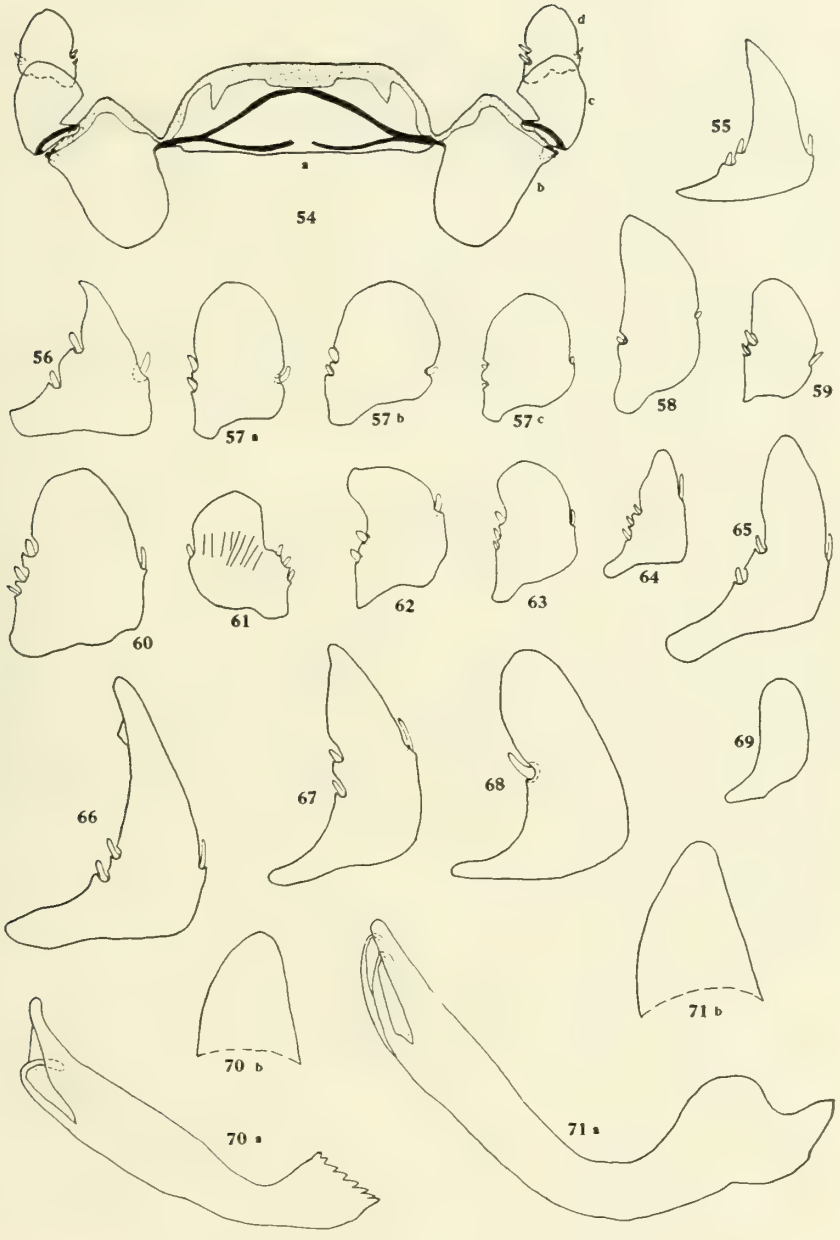


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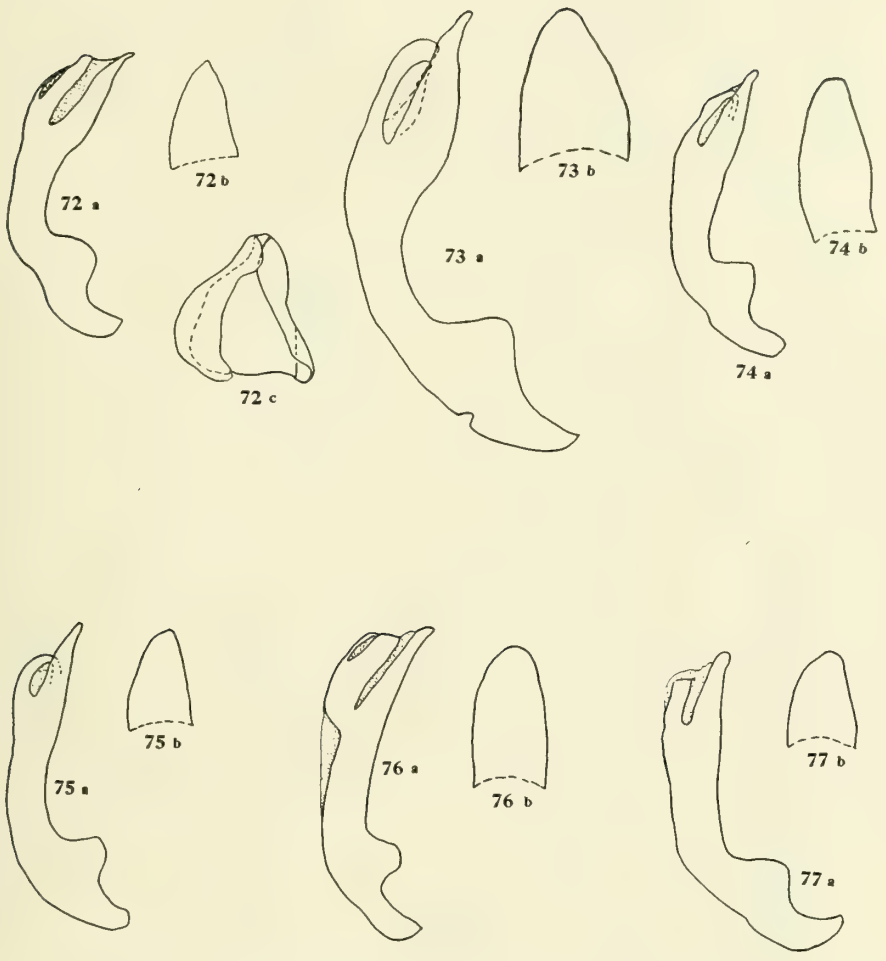


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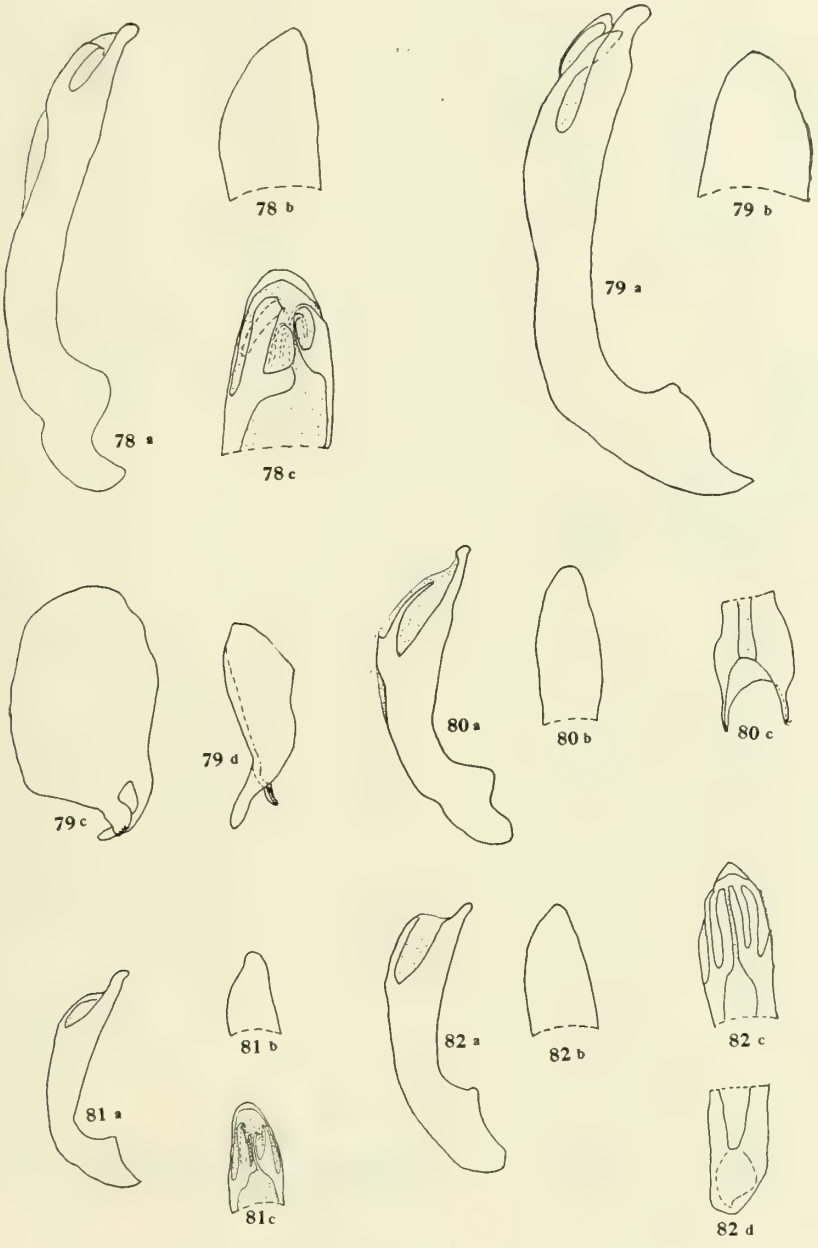


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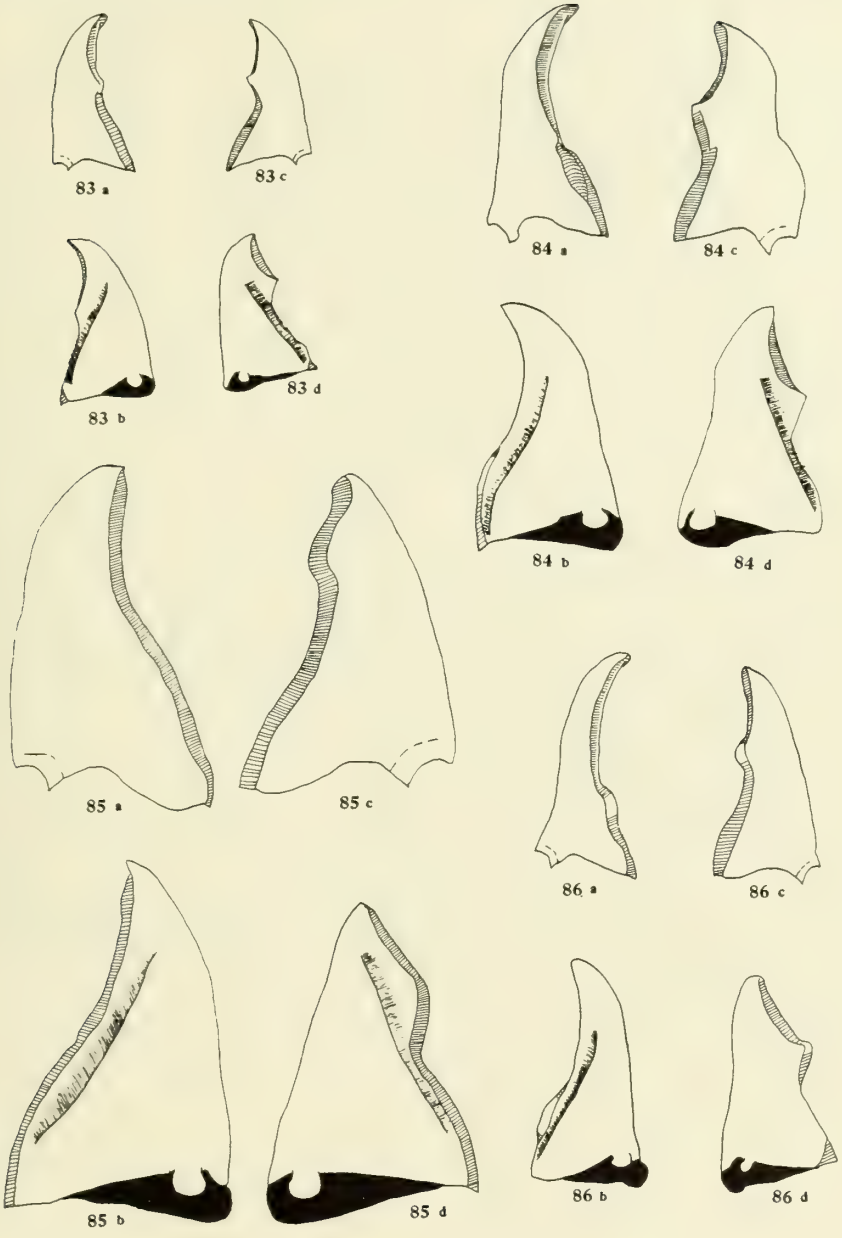


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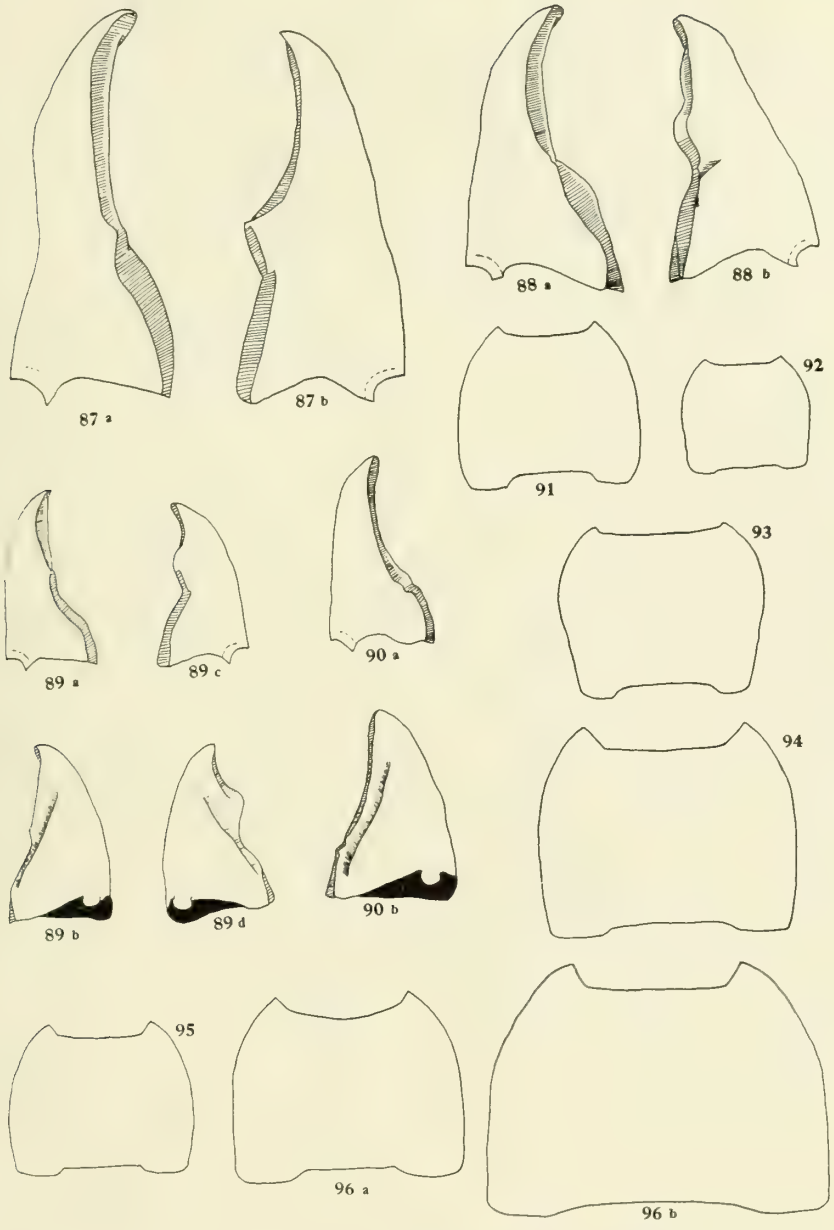


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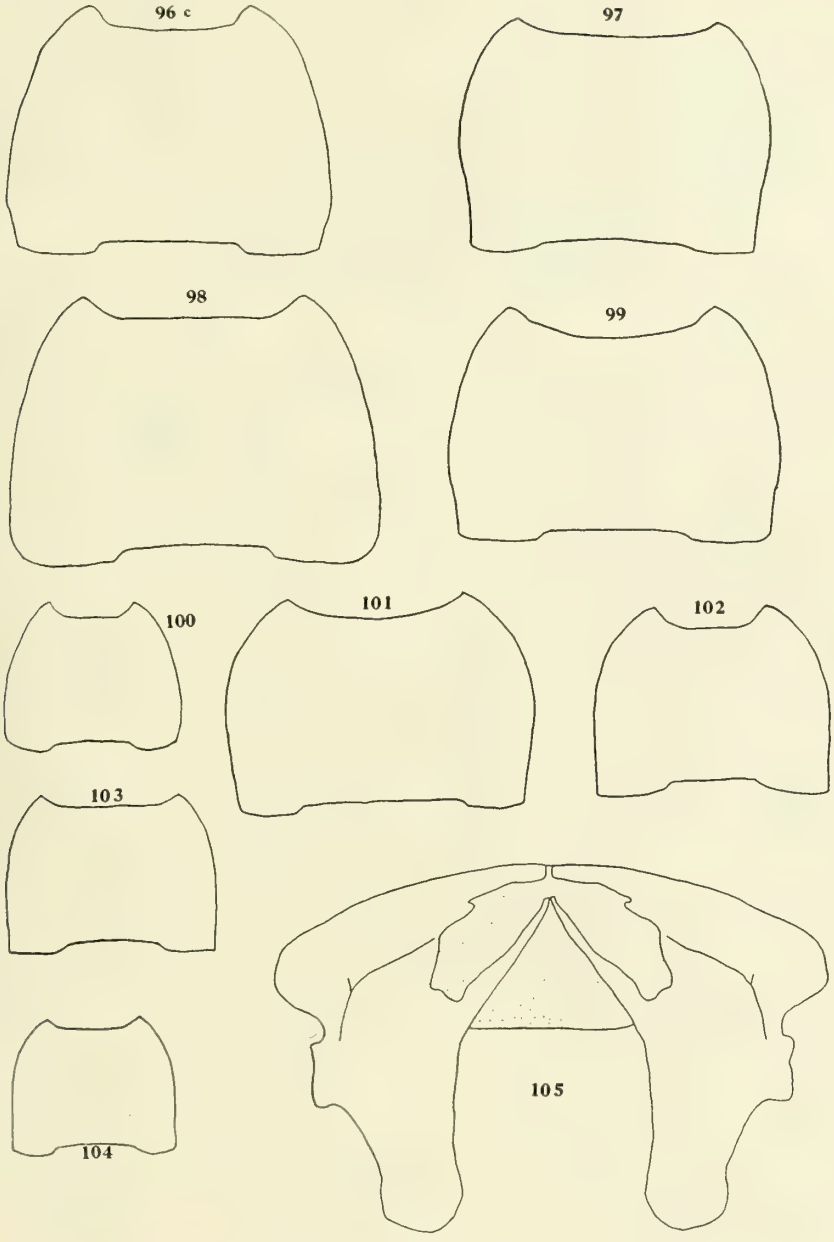


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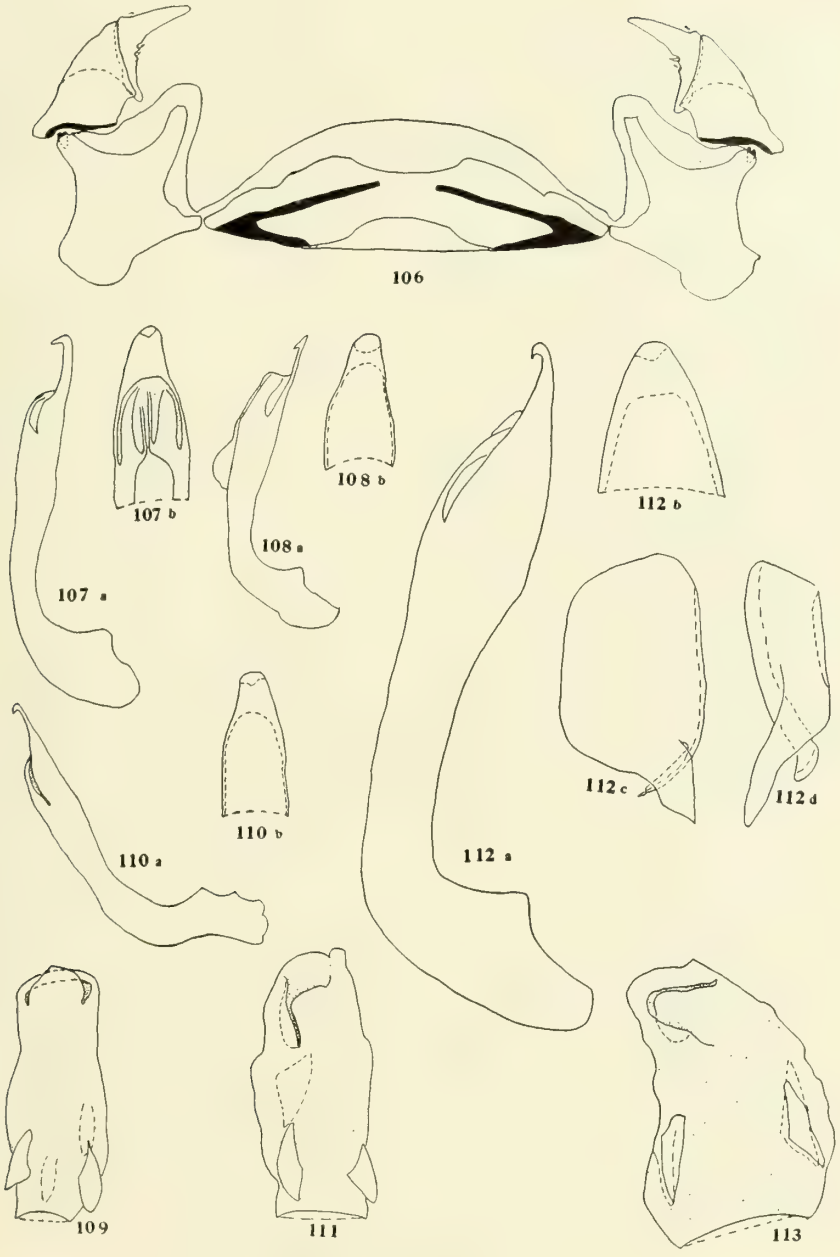
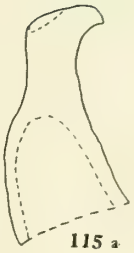



BALL—NORTH AMERICAN LICININI

114 a

114 b



115 a

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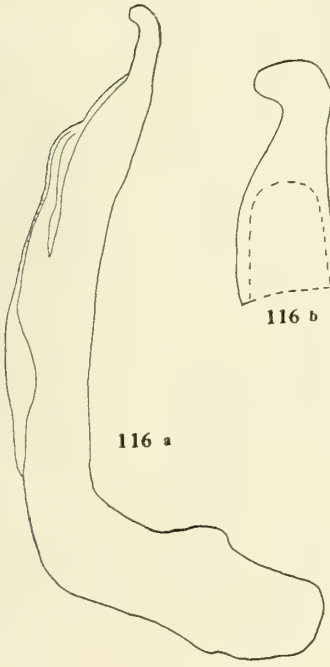

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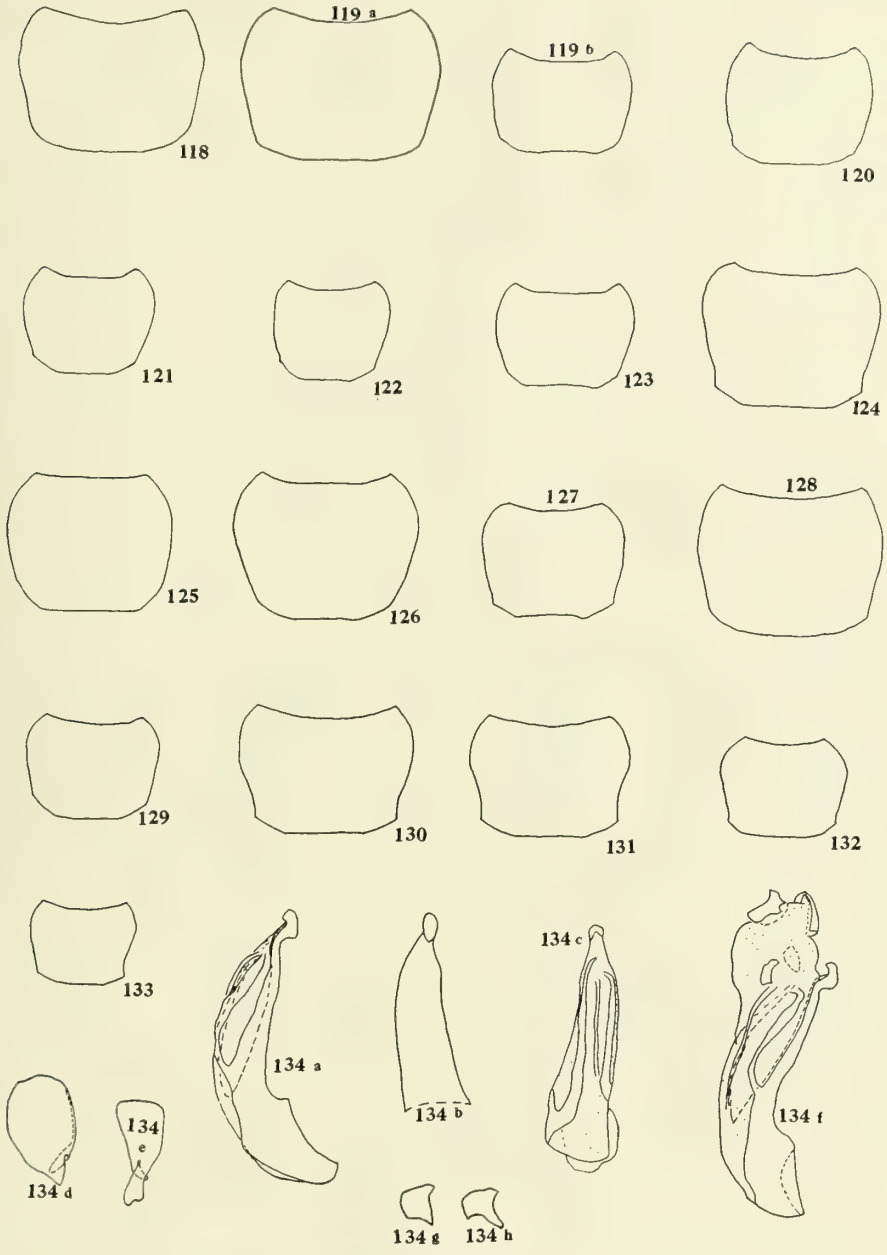


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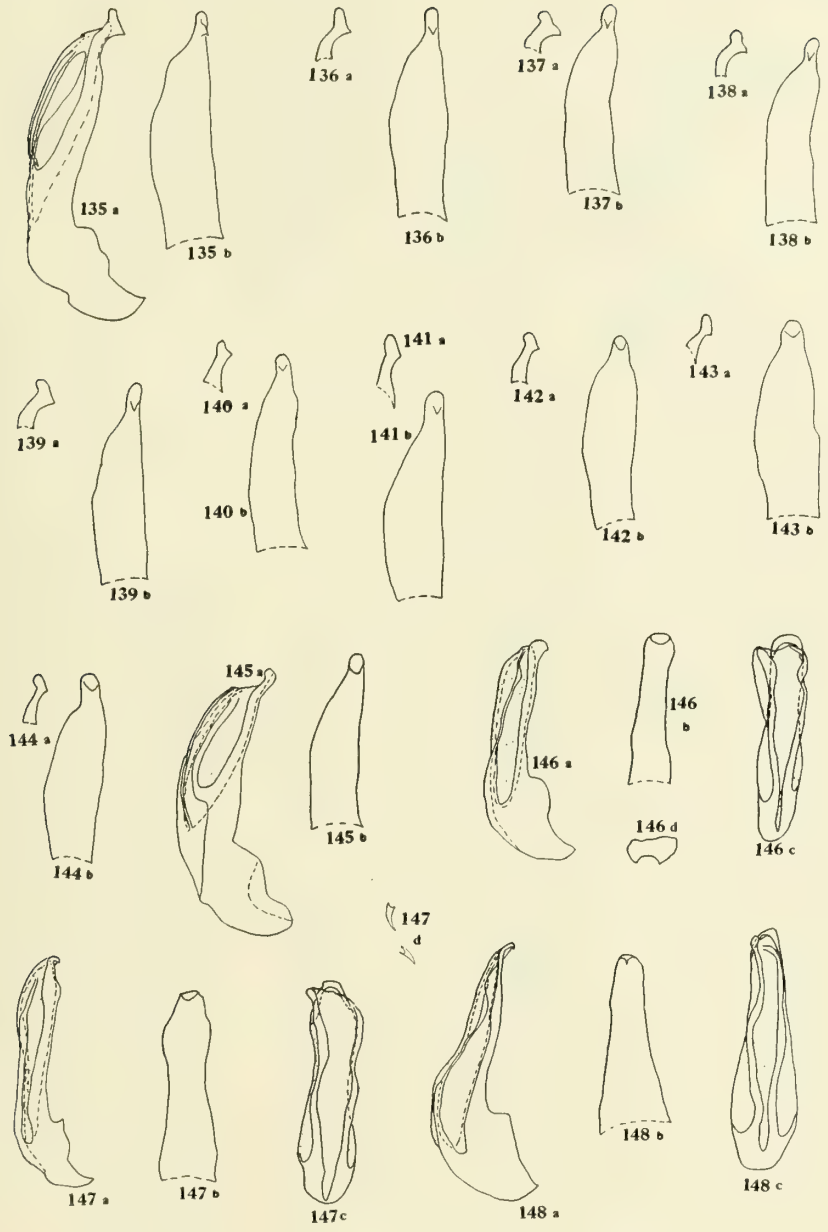


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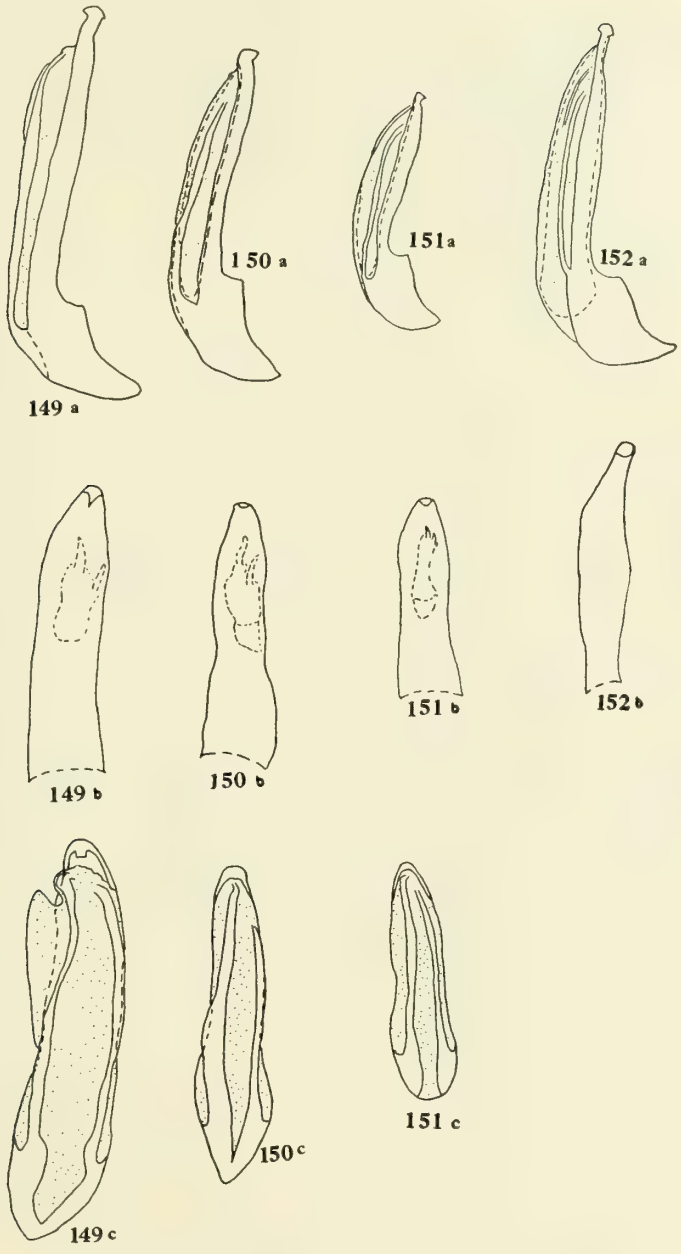


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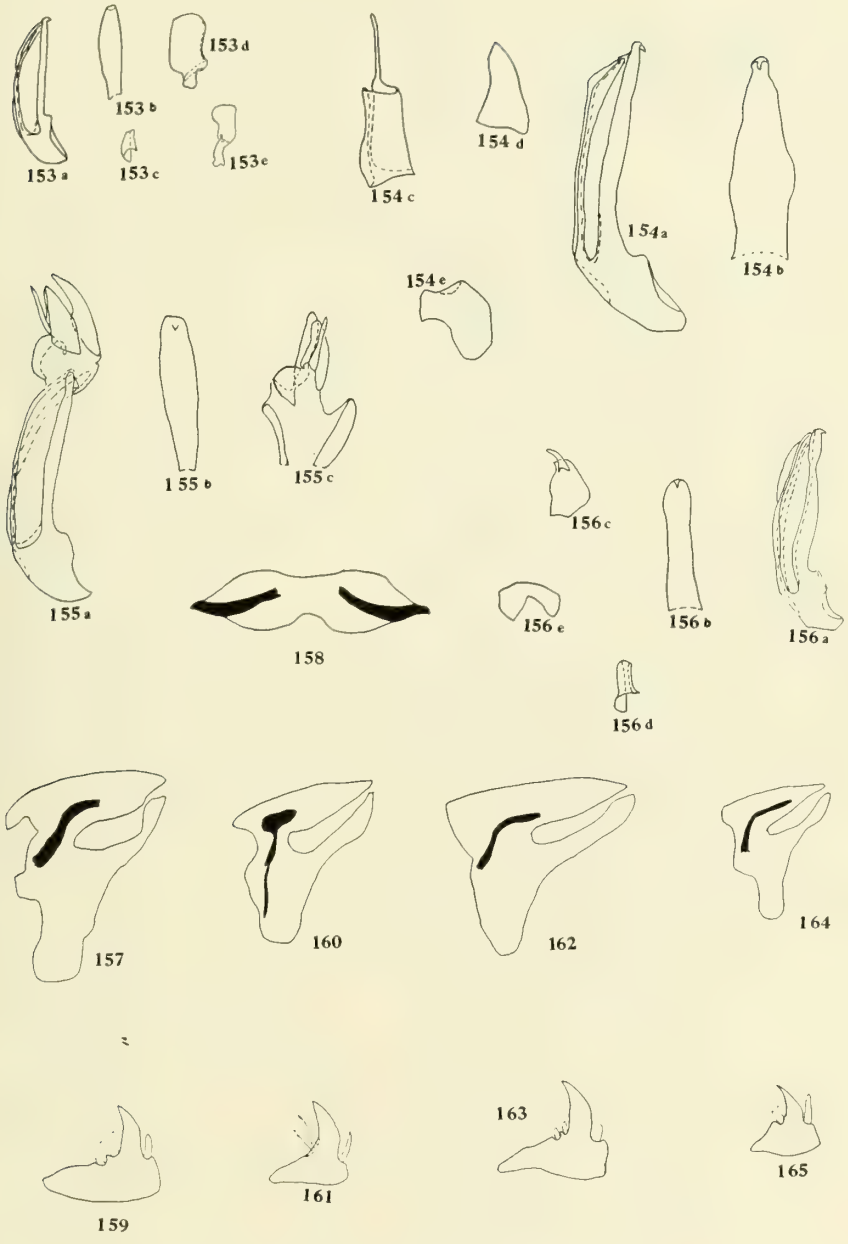


BALL—NORTH AMERICAN LICININI

# INDEX

All names printed in **bold face** are synonyms.
When more than one reference is given, the page on which the description or diagnosis appears is indicated by **bold face** type.


abbreviations (used to designate measurements), 4
*aegyptiaca* Dejean, 55
  mandibles, 19
*aegyptiaca* group, 53
*Aeneides hardii* Taylor, 173
**alternans** Casey (*Diplocheila*), 60
*alternans* Dejean (*Dicaelus*), 162
  *alternans alternans* Dejean, 163
  *alternans subtropicus* Casey, 164
*alutaceus* Horn, 102
*ambiguus* Laferté, 112
**ambiguus** Le Conte, 106
**Amblychus,** 191
**amplipennis** Casey, 60
**angusticollis** Blatchley, 72
**angustus** Casey (Badister), 215
**angustus** Casey (Dicaelus), 110
**ashevillensis** Casey, 106
*assimilis* Le Conte, 66
  *assimilis assimilis* Le Conte, 67
  *assimilis planulata* Casey, 71
*alter* Sloane, 20
*Atrotus*, 7

*Badister*, 7, 189
  phylogeny, 231
  zoogeography, 237
*Badister* (subgenus), 191
  classification of species, 193
  key to species, 192
Badisteritae, 5, 6
*Baudia*, 219
  classification of species, 221
  key to species, 220
*bipustulatus* complex, 195
*bipustulatus* Fab., 191, 194
*bipustulatus* group, 194
**brevicollis** Casey, 60

Callistidae, 6
Callistomorphi, 6
*Calyptogonia*, 20
**capensis** Laferté, 55, 57
**capensis** Peringuey, 55, 56
*carinatus* Dejean, 122
**carolinensis** Casey, 130
*cassideus*, 190
**chalybeus** Dejean, 153
*chermocki* new species, 175
Chlaenidae, 5
Chlaeniidea, 5
Chlaeniina, 5
**cliens** Casey, 67
*colossa* Bates, 26
  mandibles, 18
*Colpostoma*, 7
*confinis* Stephens, 217
**confusus** Le Conte, 154
*cordicollis* Laferté, 54
  mandibles, 18
*costatus* group, 165
*costatus* Le Conte, 166
  mandibles, 100
*costatus lerdoensis* Bates, 166, 167
*crenatus* group, 161
*crenatus* Le Conte, 161
*crux-minor* Oliv., 191
**cyaneus** Dejean, 153

*daldorfi* Crotch, 25
  mandibles, 18
*daldorfi* group, 24
*darlingtoni* Fall, 159
**debiliceps** Casey, 106
**decoloratus** Le Conte, 156
**dejeani** Dejean, 130
*Dicaelus* Bonelli, 98
  classification, 102
  fossil species, 102

mandibles, 99
phylogeny, 182
zoogeography, 185
*Dicaelus* (subgenus), 145
key to species, 148
Dicoelites, 5
*Dicrochile, 2, 7*
*dilatatus* (Badister), 221
**dilatatus** Brimley (*Dicaelus*), 130
*dilatatus* Say (*Dicaelus*), 126
*dilatatus dilatatus* Say, 130
*dilatatus sinuatus* new subspecies, 132
*Dilonchus, 2,* 5, *7*
*Diplocheila* Brullé, 12
classification, 20
mandibles, 13
phylogeny, 86
scutellar stria, 19
zoogeography, 95
*Diplocheila* (subgenus), *22*
key to species, 23
*Diplocheilus, 22*
*Diplochila, 22*
**distinguenda** Andrewes, 29
*distinguenda* Laferté, 31

**Eccoptogenius,** *22*
*elegans* group, 205
*elegans* Le Conte, 195, **205**
*elongata* Bates (*Diplocheila*), 31
*elongatus* Bonelli (*Dicaelus*), 106
*elongatus* group (*Dicaelus*), 106
*Eurygnathus, 7*
*Eutogeneius, 7*
**evanescens** Casey, 170
*exotica* Andrewes, *27*
**expansa** Casey, 75

*fenestratus* Semenov, 194
*ferrugineus* Dejean, 194, **197**
*ferrugineus anthracinus* Le Conte, 200
*ferrugineus ferrugineus* Dejean, 198
**flavicornis** Casey, 211
*flavipes* Le Conte, 209
*flavipes flavipes* Le Conte, 195, **210**
*flavipes laticeps* Blatchley, 211
*flavipes mexicanus* Van Dyke, 213
*flohri* Bates, 102, 173
**foveata** Casey, 67
*furvus* Dejean, 117
*furvus carinatus* Dejean, 122
*furvus furvus* Dejean, 120
*furvus* group, 117

*Genycerus,* 5, *7*
**gigas** Bates, 49
**gilvipes** Casey, 215
*goryi, 7*
*grandiceps* Casey, 224
*grandiceps* group, 224

Harpalinae, 6
*Helluomorphoides,* 188
**herbstii** Dejean, *32*
*Hormacrus, 2, 7*

*Icterus,* 188
**impressicollis** Le Conte, 60
**impressus** Fab., *25*
**impressus** Redtenbacher, *26*
*indicus* Herbst., *32*
" *indus* complex," *29*
*indus* Dejean, *32*
*intricatus* Chaudoir, 142
**iricolor** Le Conte, 154
*Isorembus,* 48
key to species, 48

Key to genera of North American *Licinini,* 10
genera of Oriental *Licinini,* 11
species of *striatopunctata* group, 59
species of subgenus *Badister,* 192
species of subgenus *Baudia,* 220
species of subgenus *Dicaelus,* 148
species of subgenus *Diplocheila,* 23
species of subgenus *Isorembus,* 48
species of subgenus *Liodicaelus,* 169
species of subgenus *Paradicaelus,* 104
*kineli* Makolski, 194

*lacertosus* Sturm, 194
*Lacordairia*, 2, 7
*laevigata* Bates, 35
*laevigatoides* Jedlička, 36
*laevipennis* Le Conte, 169
  *laevipennis abbreviatus* Bates, 174
  *laevipennis dicaeloides* new subspecies, 172
  *laevipennis flohri* Bates, 173
  *laevipennis laevipennis* Le Conte, 170
*laevis* Lesne, 52
*laticeps* Blatchley, 195
**laticollis** Casey, 67, 71
**laticollis** Le Conte, 67
*latifrons* Dejean, 41
  mandibles, 14
*latifrons darlingtoni* new subspecies, 44
*latifrons latifrons* Dejean, 42
**lecontei** Laferté, 158
**leonardi** Harris, 110
*Lestignathus*, 7
Licines, 5
Licini, 5
Licinidae, 5, 6
Licinides, 5
Licinina, 5
Licinini, 5
  classification, 6
  diagnosis, 5
  geographical distribution, 7
  key to North American genera, 10
  key to Oriental genera, 11
  mandibles, 6
Licinitae, 5, 6
Licinites, 5
*Licinus*, 7
Limbata Conchifera, 6
*Liodicaelus*, 168
  key to species, 169
*Loxomerus*, 20

*macromandibularis* Habu & Tanaka, 52
  mandibles, 19
*maculatus* Le Conte, 195, **207**
*major* Le Conte, 74
  *major major* Le Conte, 75
  *major melissisa* new subspecies, 78
mandibles of *Dicaelus*, 99
  of *Diplocheila*, 13
  of *Licinini*, 6
*Martyr*, 7
measurements, 3
*Mecynognathus*, 7
*mexicanus* Van Dyke, 195
**micans** Le Conte, 226
*Microferonia*, 7
*Microhyla*, 188
*minima* Jedlička, 47
*modesta* Casey, 64
**moestus** Chaudoir, 31

*nebrioides*, 20
*nemoralis* Mulsant, 13
*neopulchellus* group, 195
*neopulchellus* Lindroth, 194, **195**
*Neorembus* new subgenus, 40
*notatus* Haldeman, 195, **215**
*nupera* Casey, 72

**oblonga** Casey, 75
**obscurus** Le Conte, 106
*obtusa* Le Conte (Diplocheila), 80
*obtusus* Le Conte (Badister), 194, **201**
**ocellatus** Blatchley, 141
*ocularis* Casey, 226
*Omaseus*, 33
*Omestes*, 2, 7, 9
**opacus** Bates, 42
**opacus** Laferté, 112
**opacus** Le Conte, 106
*oregona* Hatch, 63
**ovalis** Le Conte, 120
**ovipennis** Casey, 114

Panagaeidae, 6
*Paradicaelus* new subgenus, 103
  classification, 105
  key to species, 104
**parallela** Casey, 80
*parviceps* new species, 225
Patellimanes, 5
*peltata* Panzer, 190, 221

**percissa** Andrewes, 32
*Peromyscus,* 188
phylogeny, *Badister,* 231
*Dicaelus,* 182
*Diplocheila,* 86
*Physolesthus,* 7
*pictus* Bates, 194
*pinodes* Andrewes, 51
**planicollis** Le Conte, 130
*planulata* Casey, 71
*Platylytron,* 2, 7
*polita* Fab. (*Diplocheila*), 29
mandibles, 14
*polita* group (*Diplocheila*), 27
**politus** Dejean (*Rembus*), 32
*politus* Dejean (*Dicaelus*), 110
*politus* group (*Dicaelus*), 109
**procera** Casey, 75
*Pterostichus,* 33
*pulchellus* complex, 204
*pulchellus* group, 204
*pulchellus* Le Conte, 204
*purpuratus* Bonelli, 150
*purpuratus darlingtoni* Fall, 159
*purpuratus purpuratus* Bonelli, 153
*purpuratus quadratus* Le Conte, 158
*purpuratus splendidus* Say, 156
*purpuratus* exerge, 153
*purpuratus* group, 150

*quadratus* exerge, 158
*quadratus* Le Conte, 158
"*quadricollis* complex," 29
*quadricollis* Laferté, 30

**rectificatus** Bates, 29
*reflexus* group (Badister), 222
*reflexus* Le Conte (*Badister*), 222
**reflexus** Le Conte (*Dicaelus*), 112
"*Rembe,*" 22
**Rembus,** 22
**retinens** Walker, 29
**Rhembus,** 22

**scapularis** Stephens, 217
*sculptilis* Say, 137
*sculptilis intricatus* Le Conte, 142
*sculptilis sculptilis* Say, 141
*sculptilis upioides* new subspecies, 144
scutellar stria (*Diplocheila*), 19
**seclusus** Blatchley, 222
**senegalensis** Dejean, 55
**Shirahataia,** 21, 48
*Siagonyx,* 2, 6, 7
**simplex** Dejean, 106
*sodalis* Duftschmid, 190, 217
species (criteria for), 3
**speciosus** Casey, 156
*splendidus* Say, 156
*striatopunctata* group, 57
key to species, 59
*striatopunctata* Le Conte, 60
*submarinus* Motschulsky, 228
**Submera,** 40, 48
**subpunctatus** Laferté, 32
subspecies (criteria for), 3
*subtropicus* Casey, 164
*suffusus* Casey, 177
**Symphyus,** 22

**terminalis** Le Conte, 215
*teter* Bonelli, 114
Thoraciques, 5
*torta* Andrewes, 2
*transcaspica* Semenov, 54
*transversus* Casey, 217
*Tricholicinus,* 7
*Trimorphus,* 217
*Tropidopsis tridentata* Say, 155
**turbulentus** Le Conte, 112

*undulata* Carr, 82
**unicolor** Nietner, 29
*unipustulatus* Bonelli, 194

*vandykei* new species, 195, **206**
**violaceus** Bonelli, 153

*Zargus,* 7
*zealandica* group, 49
*zealandica* Redtenbacher, 49
mandibles, 14
zoogeography, *Badister,* 237
*Dicaelus,* 185
*Diplocheila,* 95

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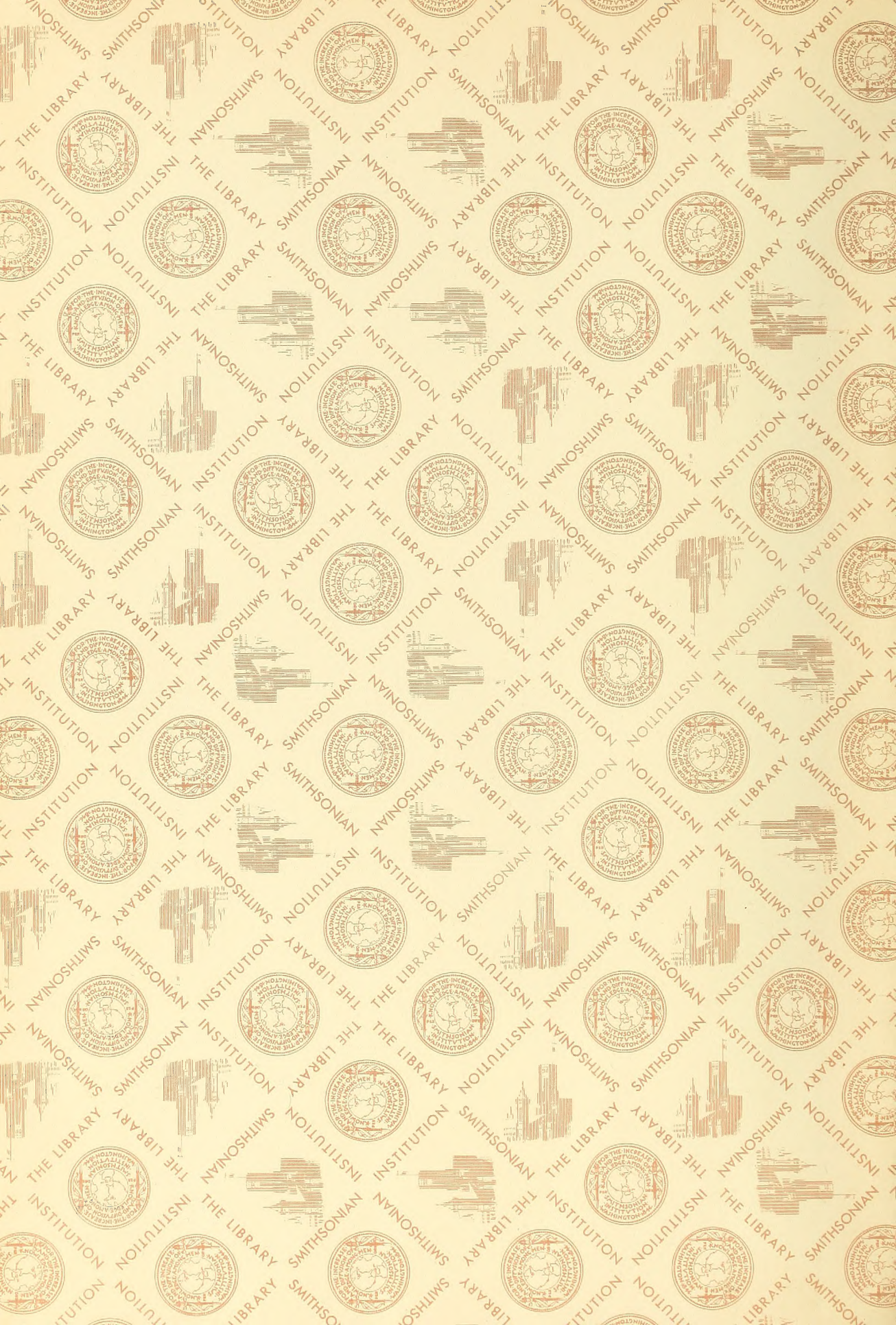
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